The American Journal of Surgery

EDITED BY THURSTON SCOTT WELTON, M.D.

May 1942

War Surgery

Gynecology . Anesthesia

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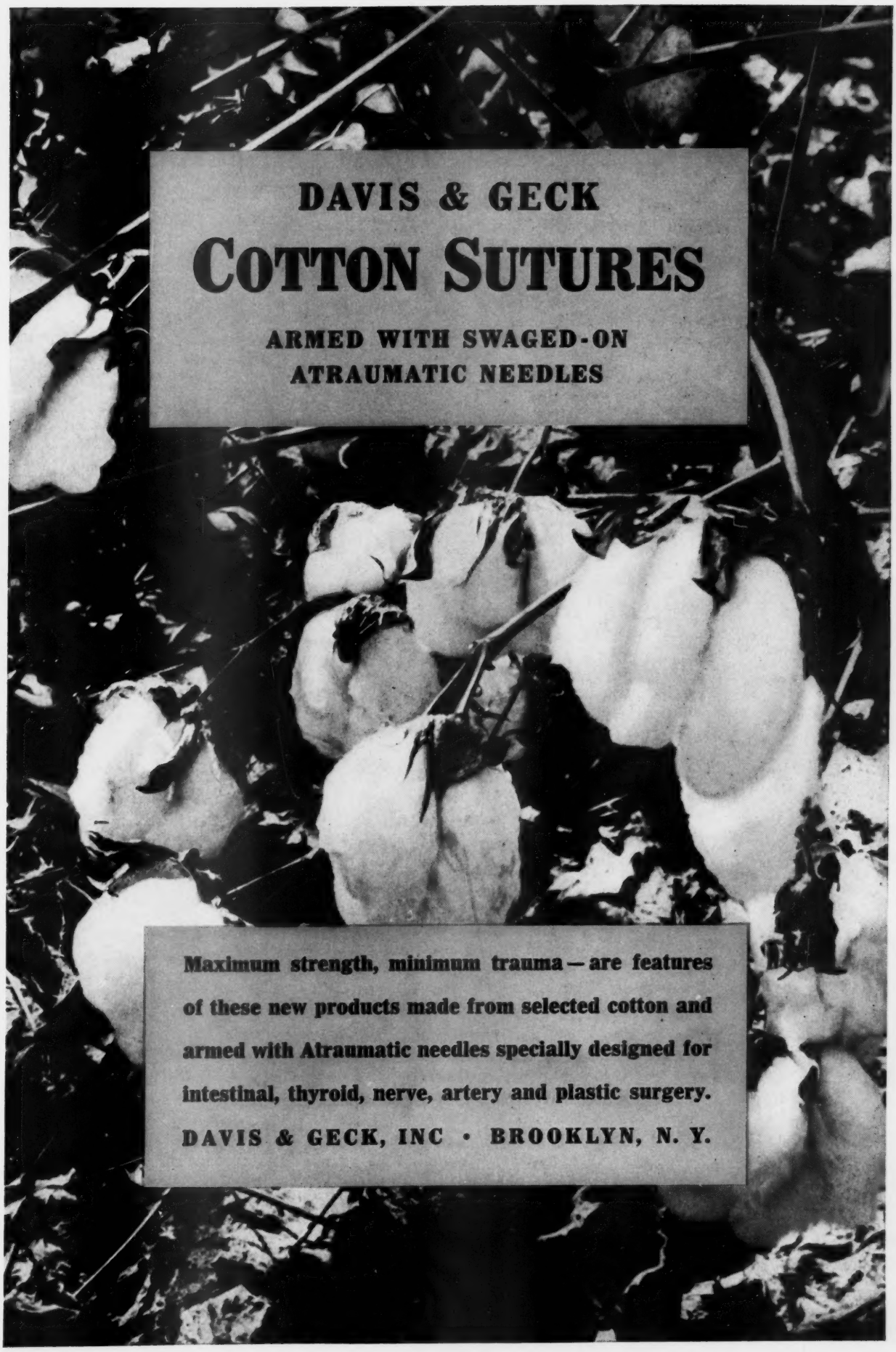
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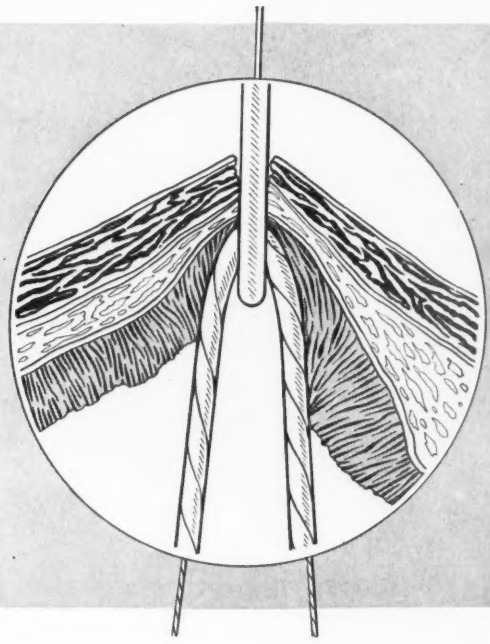

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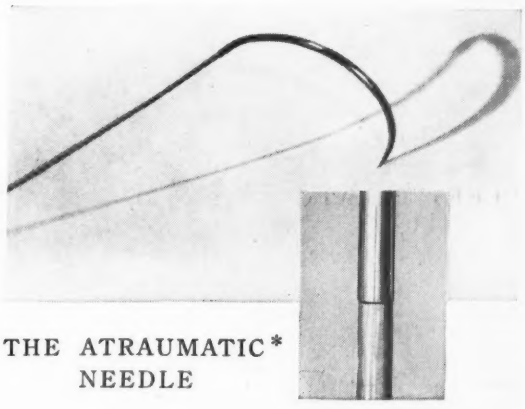

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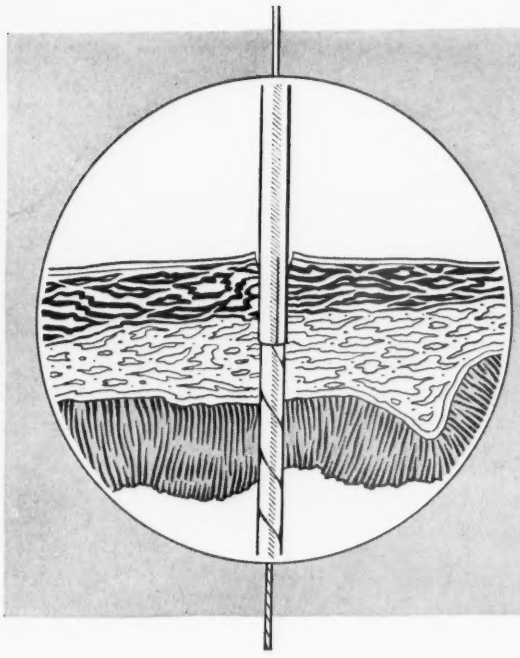

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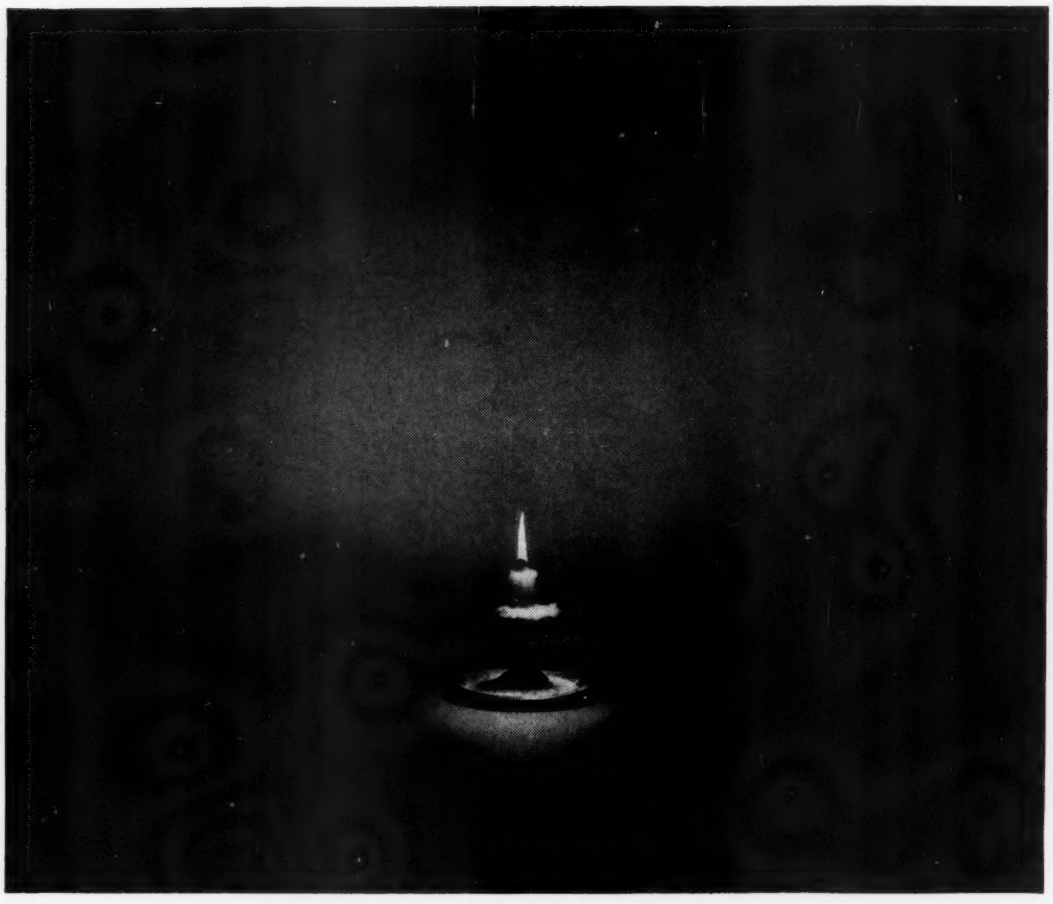

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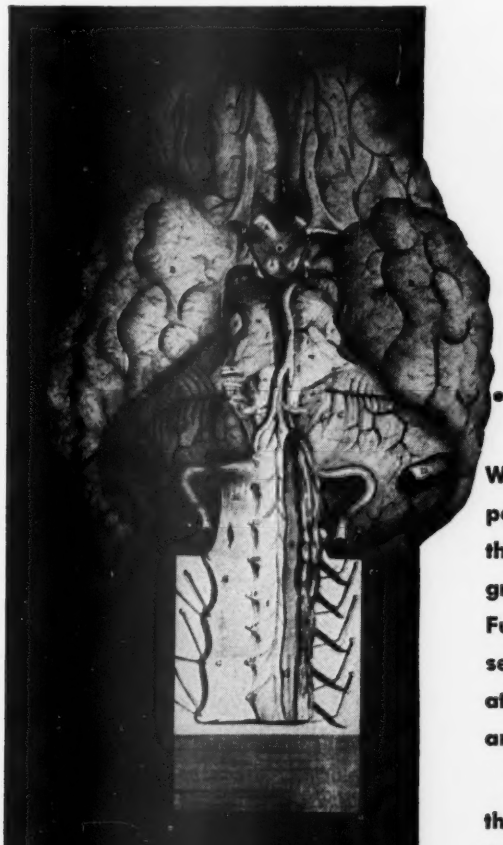
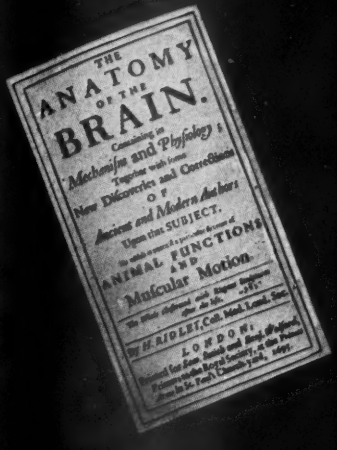


From the "elegant sculptures after the life" which are found in that classic anatomical volume of 1695, credited to H. Ridley—"The Anatomy of the Brain."



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1. Council Report: J.A.M.A., 113: 1734, 1939
2. Merritt, H. H. & Putnam, T. J.: A. J. Psychiat., 96: 1023, 1940

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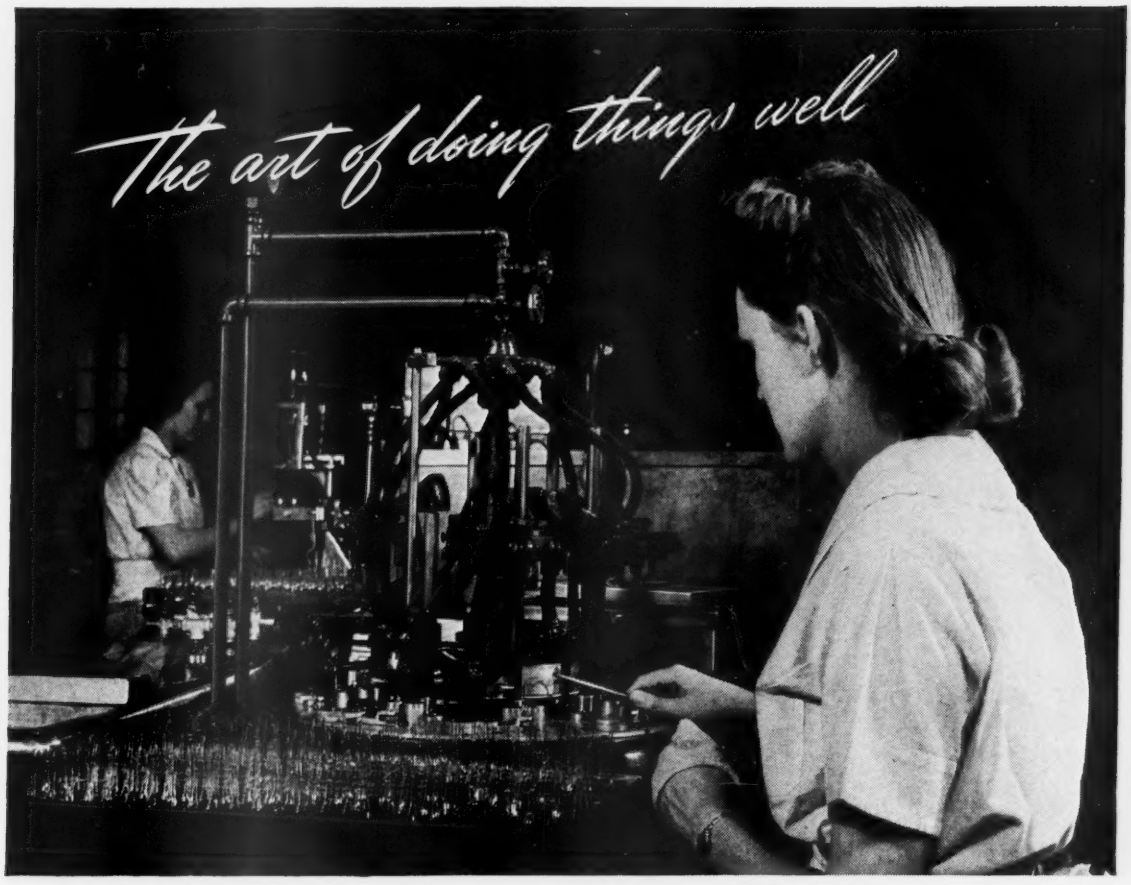

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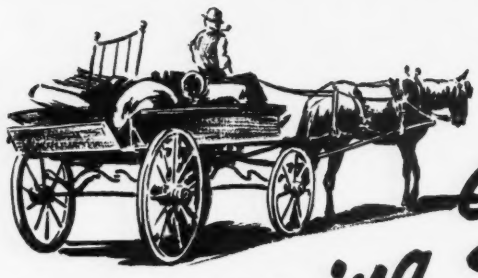

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—NATION'S BUSINESS

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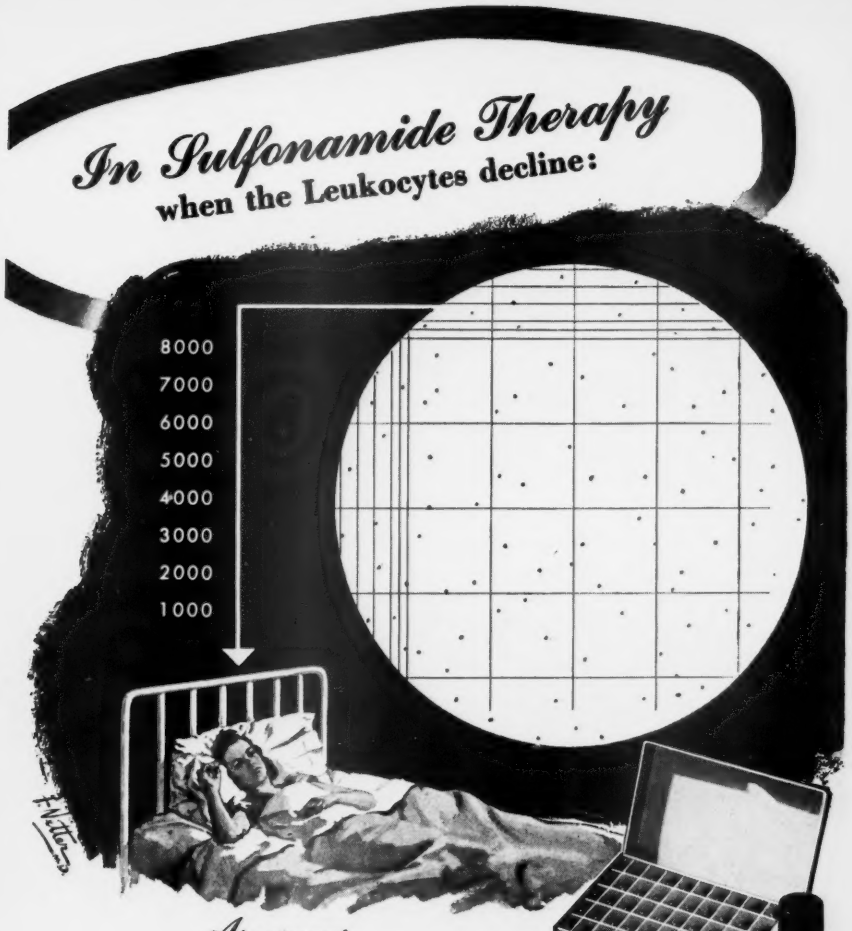

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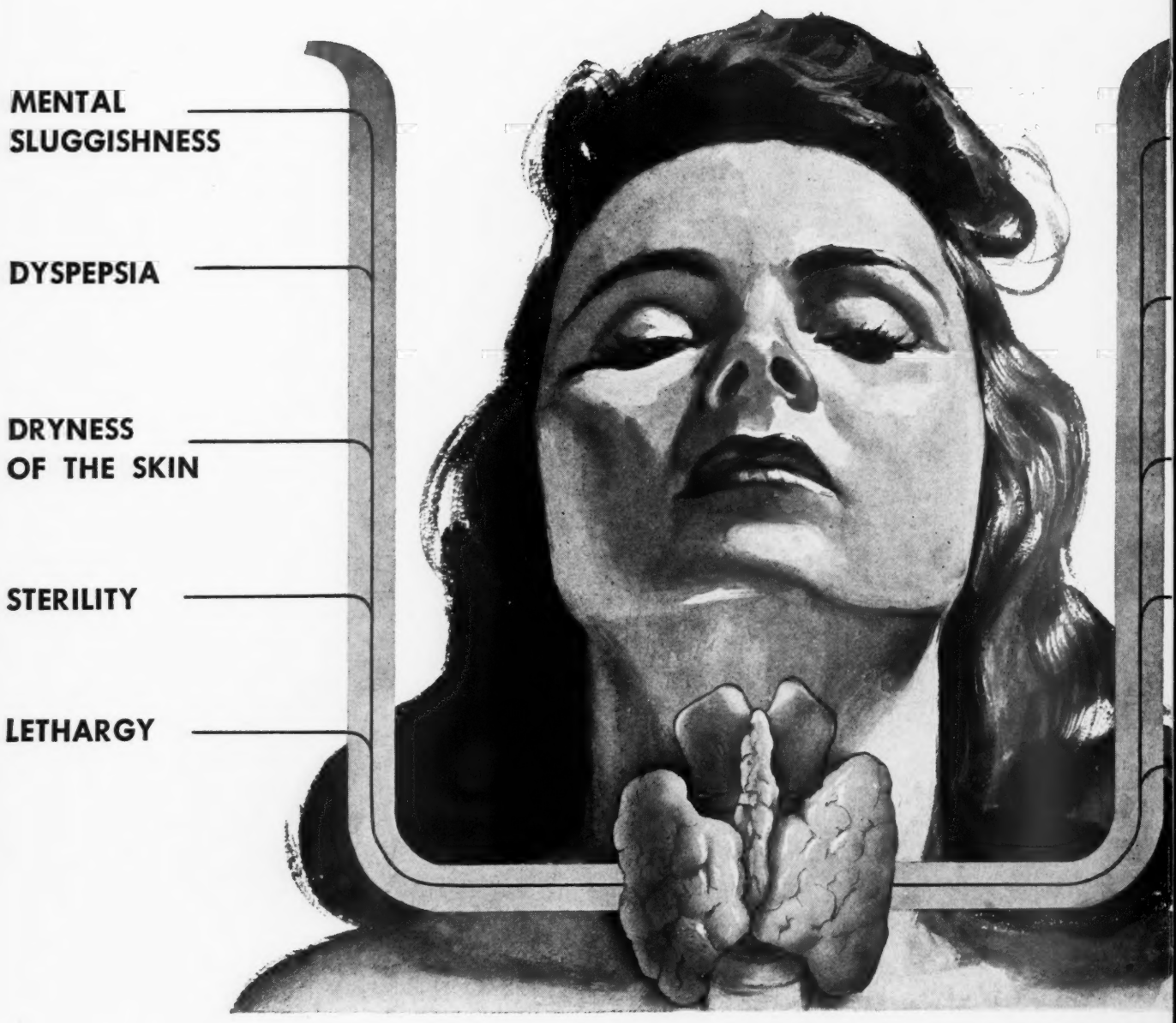

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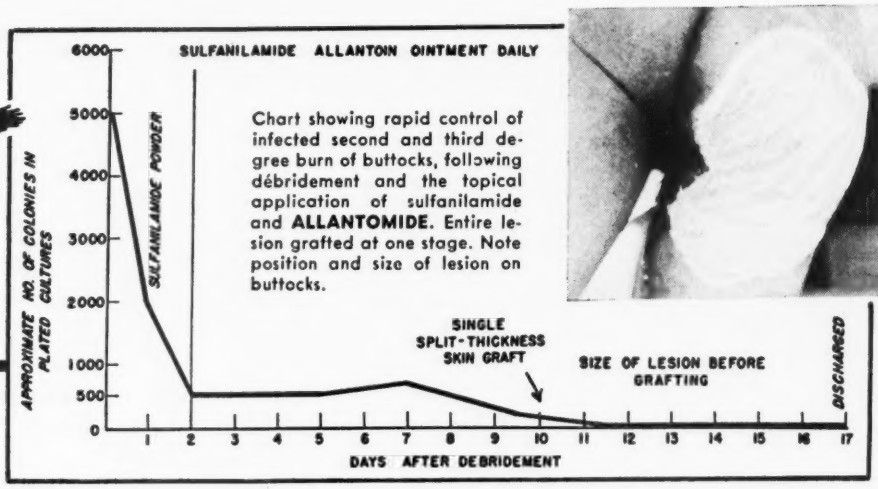

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*Veal, J. R.; and Klepser, R. G. (Surgery, Vol. 10, No. 6, Dec. 1941, 947)
**Veal, J. R.; Klepser, R. G.; and DeVito, Michael P. (Amercian Journal of Surgery, Vol. 54, No. 3, Dec. 1941, 716)

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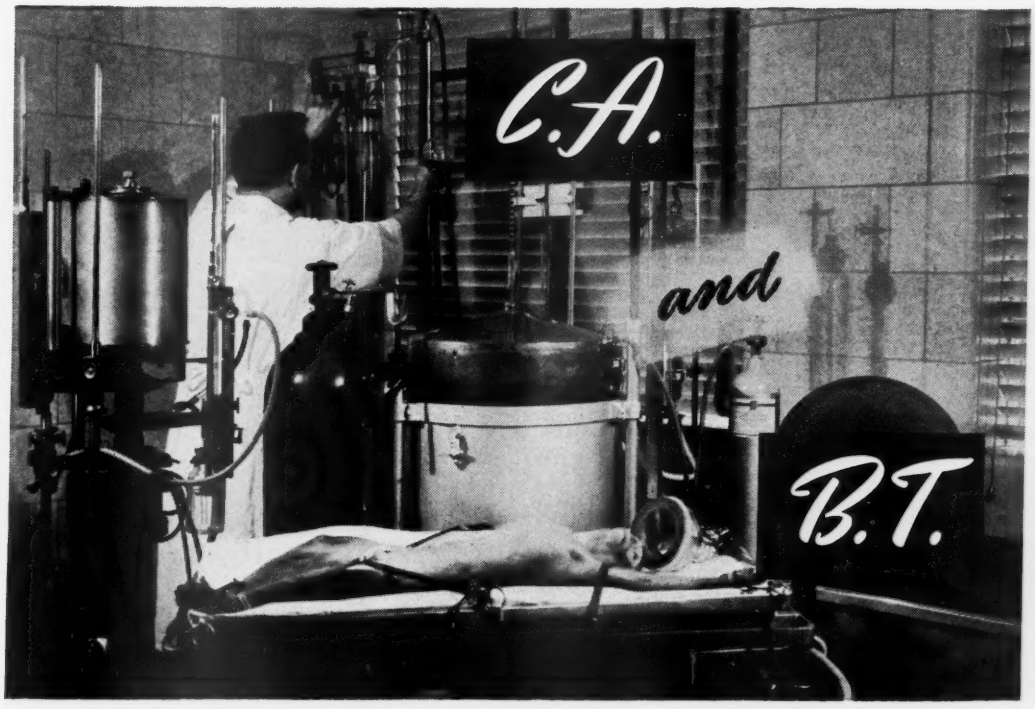

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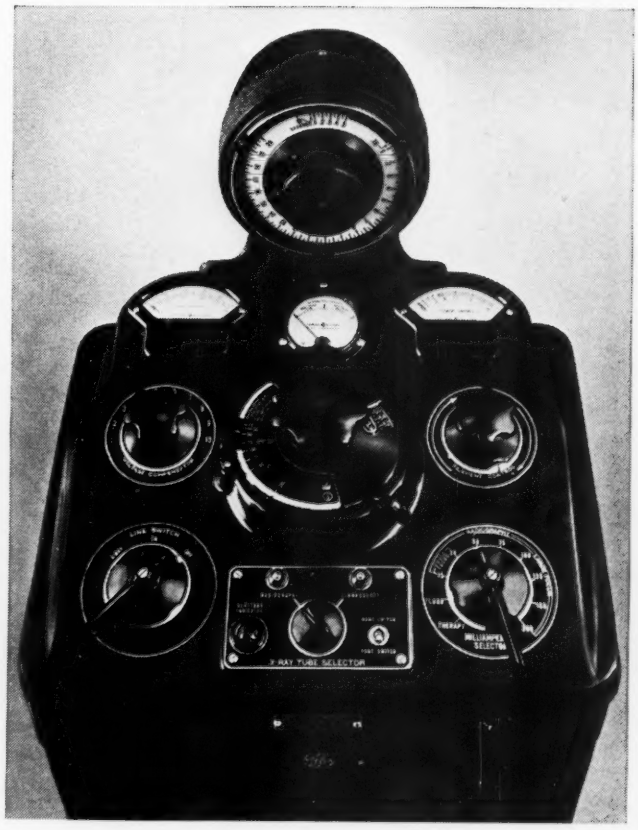

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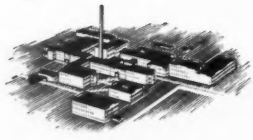

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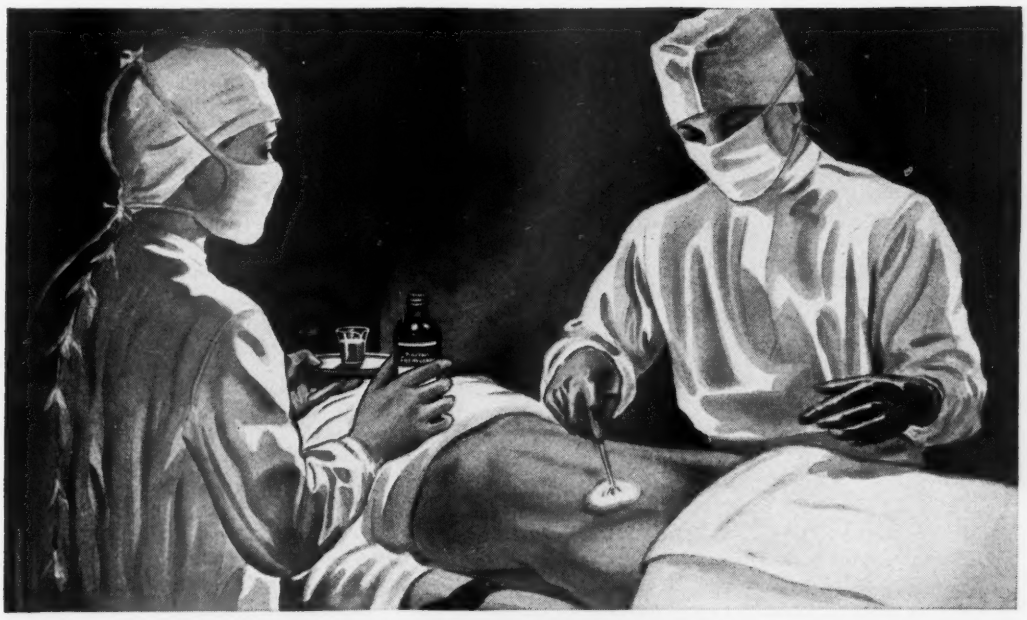

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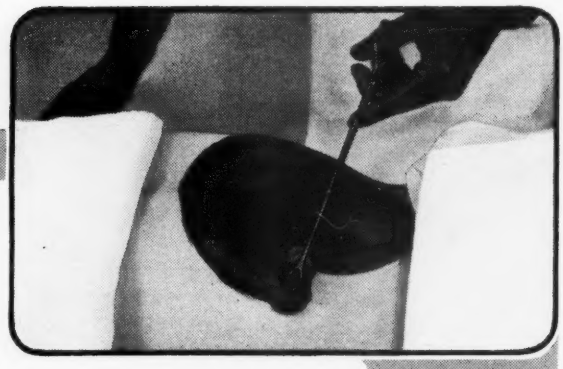

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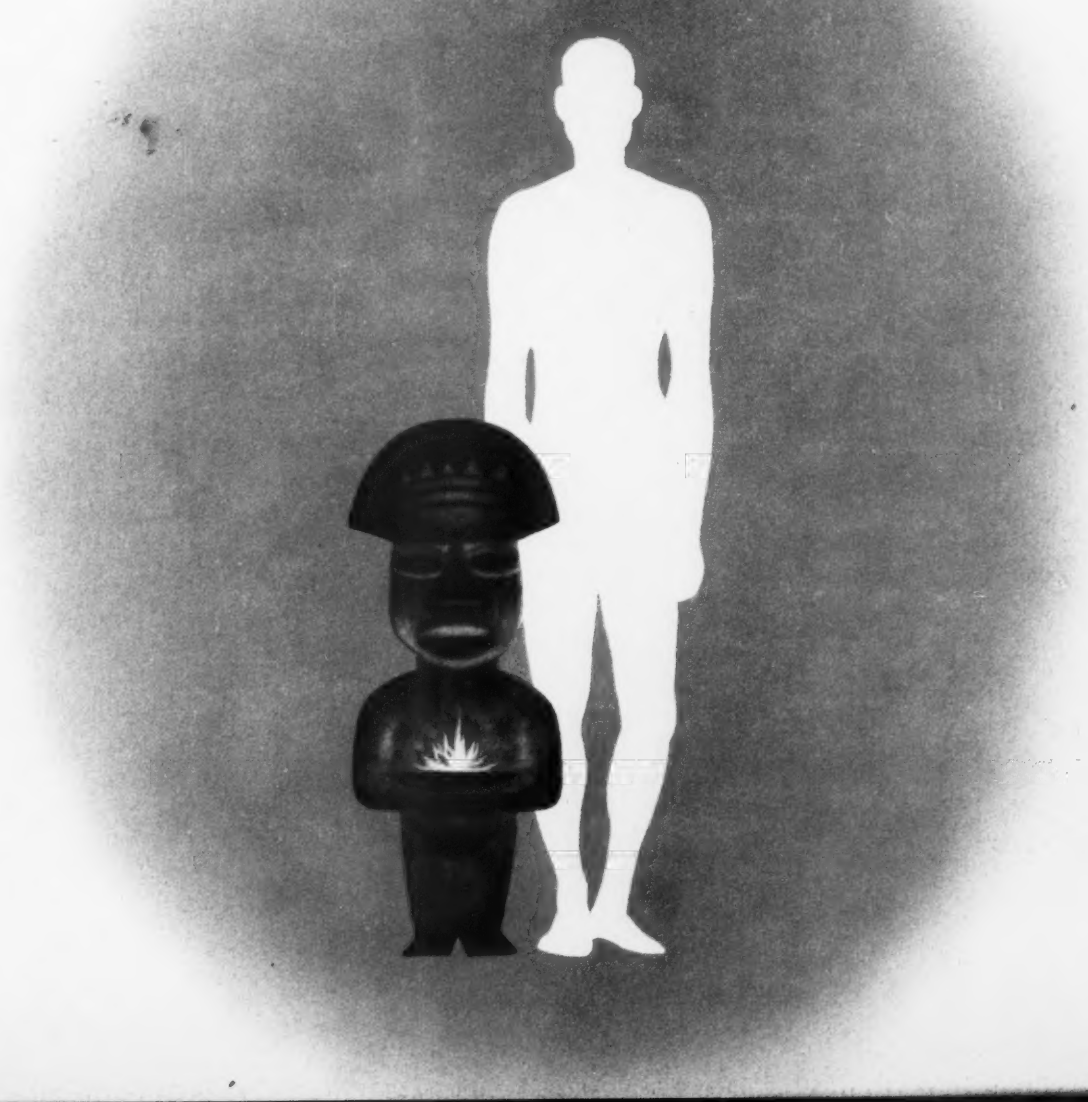

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A PRACTICAL JOURNAL BUILT ON MERIT

NEW SERIES VOL. LVI MAY, 1942 NUMBER TWO

Editorial

THE IMPORTANCE OF A KNOWLEDGE OF VASCULAR SURGERY IN WORLD WAR II

MILITARY and naval figures detailing the severe and fatal injuries at Pearl Harbor brought home to American surgeons the terrifically destructive effect of the modern bomb. The number of those killed equalled the number wounded and this relatively high number of fatalities in relation to the total men injured was a new experience to us all.

One of the surgeons present at the bombing reported that of 600 admissions to one hospital, approximately 400 were of the type classed as serious. He was present at all major offenses in the last war, but never saw such a high percentage of serious injuries.

The surgeons of the Army of the United States and the Navy, hastily summoned from hospital and civil practices, will be confronted, therefore, not only with voluminous traumatic surgical problems, but in 75 per cent of the instances, major wounds. The transition to military surgery will be difficult and in no field more so than in the understanding of the underlying vascular problems. The decision whether to amputate or not must be made by the operating surgeon and on the correctness of his choice will depend the limb and often the life of the injured man. Experience in large vascular clinics demonstrates that training along vascular lines has been neglected, not only in medical schools but in hospital and postgraduate training as well. It is too late to supply this training to these transformed military surgeons except in a very general way.

The life of an individual or any of his parts depends on the blood supply. Nature has protected his life line by an adequate supplementary blood system which functions when the main one is injured. This system temporarily carries the nutrition. If judiciously stimulated, in many instances it will function permanently. One misconception requiring correction is that laceration or loss of a part of a major vessel necessarily requires amputation of the extremity. Large arteries may be sutured and the circulation restored even after several hours have elapsed. The suture material and needles must be fine and must not enter the intima. Very few sutures are necessary, as the pressure on the vessel wall is inverse to the rate of flow. By removing the vessel from its bed and flexing the limb, defects up to 4 or 5 cm. may be overcome and the artery sutured end-to-end. Contiguous vein tissue may be used as an arterial transplant to replace sections

of arteries. This type of surgery has been successful, particularly since the introduction of heparinization and the new drug, dicoumarin. Perivertebral sympathetic nerve blocks with novocaine solution, producing sympathectomy effect not only relax spasm in the vessels, permitting restoration of this circulation, but also dilate the vessels of the collateral circulation and thus help maintain the nourishment of the part. Judicious application of a tourniquet just proximal to the laceration or the use of a clamp on the vessel itself, may permit circulatory restoration, if not maintained for too long a time. The tourniquet, if used, should cause minimal trauma and should be well padded. A tag with the hour and minute it was applied should be attached.

When the major vessel has been tied or its re-establishment is impossible, the limb is not necessarily lost. The fact that patients with thrombo-angiitis-obliterans and arterial sclerosis, in whom the major vessels are closed, can have their collateral circulation so stimulated that amputation is unnecessary, is a point to be kept in mind before amputation is decided upon. In these instances ligation of the accompanying vein reduces the incidence of gangrene.

Four factors in the stimulation of collateral circulation are: (1) External controlled heat; (2) vasodilating drugs, such as whiskey, tissue extracts such as depropanex and smooth muscle relaxing drugs like papaverine, atropin, and opiates; (3) The abstinence from tobacco. This latter is most important and bears emphasizing at the time of a major blood vessel injury. The practice of giving "smokes" to every wounded man is no more logical than the use of nicotine by the patient in the operating room; (4) perivertebral sympathetic nerve block.

The prevention of tetanus by the use of toxoid and of gas gangrene by débridement, the sulfa drugs, serum and the nonwound closure technic will all aid in the reduction of mortality.

A week's review of the vascular system and its relation to trauma under expert tutelage for men departing for active service, might be a sound investment for the return of more men to civil life with their limbs intact.

Gerald H. Pratt, M.D.

Original Articles

WAR SURGERY

FOREWORD

THIS War Surgery Symposium was presented at the regular monthly meeting, of the Medical Society of the County of New York on February 23, 1942. Each participating speaker was allowed ten minutes, and the underlying motive was to stress the treatment concisely and not the diagnostic features of the chief casualties of war. It was recognized that in a raid on our civilian population, many similar injuries might occur, and thus what follows is in reality applicable to the military as well as the civilian surgery of wartime. Purposely, nothing of first-aid character was stressed, nevertheless much information regarding so-called minor injuries is inferentially included. The participants are practitioners and teachers in their respective fields, and all of them had previous experience in World War I.

A summary of these five* presentations may be said to emphasize the following basic factors: (1) The importance of early receipt of the wounded; (2) adequate preoperative treatment to overcome shock and hemorrhage; (3) careful cleansing of the wounded area; (4) débridement; (5) use of the sulfonamides in the wound and by mouth; (6) the use of no sutures, or primosecondary suture; and (7) diligent after-care.

Naturally, certain pertinent details are given in the individual presentations, but all the speakers were in accord as to the treatment of the initiating wounds, irrespective of their site, size or severity. This unanimity of opinion should be helpful in standardizing methods of treatment in the casualty groups discussed and which include the great majority usually encountered. These articles are published in the order of their presentation.

* Dr. Byron Stookey, whose paper has not arrived in time for publication, gave an excellent presentation of the method of transporting patients with spine injuries.

WAR WOUNDS

JOHN J. MOORHEAD, M.D.
NEW YORK, NEW YORK

IT will not profit us to discuss the classification of war wounds as to source, site or size except in general terms. The current casualties are from bomb fragments and machine gun bullets in contrast to those caused by shrapnel, grenades and rifle fire so familiar in World War I. Nor is there special clinical gain by classification in terms of penetrating, perforating, tangential or other types of war wounds.

The essentials are to combat the *three horsemen of trauma*, namely, *shock, hemorrhage and infection*. Shock and hemorrhage are best defeated by such surgical ammunition as external heat, fluids, and the sovereign power of whole blood, or liquid or dried plasma. Before World War II is won, my belief is that stored blood will be in the form of capsules or tablets and perhaps even some modification permitting the use of animal blood already endowed to offset the prevailing organisms of the germ infested terrain now actually world-wide.

The treatment of the wound itself has two main objectives: one to prevent infection, the other to promote healing. We know that organisms survive only in the presence of dead or dying tissue. If we can have live tissues, we are assured of dead germs, irrespective of the source, site or size of the wound. Further we know there are two phases in our combat; one is the *contamination*, the other the *infection* phase of any wound. Hence the time element in our fight is important. Long ago we learned that any trauma treated early usually meant victory; but if treatment lagged, we yielded to complications that often meant defeat. This time element leading to victory is within the first six hours post-trauma, the Golden Period. Wounds treated then are in the *contamination phase;* treated thereafter they are in the *infection phase.*

The basic elements in wound treatment may be said to be: (1) The *time element*—within six hours post-trauma; (2) the *cleansing element*—soap and water and more soap and water until the parts are cleansed after the manner of preoperative cleansing of our hands; (3) the *excising element*—débridement. This means the removal of all damaged tissue by non-sacrificial excision until three criteria are attained: (a) the parts look healthy, (b) bleeding is present from the excised edges, and (c) muscle contracts. This process is not in terms of amount of tissue removed; it may mean one-sixty-fourth of an inch or three-fourth of an inch until the named criteria are attained. (4) The *hemostatic element*—leave the wound dry because blood, serum and macerated tissue become an autogenous culture medium, virtually a bouillon to promote growth of organisms. (5) The *sterilizing element*—place on and in the wound a sulfonamide, preferably sulfanilamide. In amount this should coat the entire area liberally. Too much rather than too little should be applied. (6) The *suture element*—if the wound is of the lacerated type, abandon any idea of suturing it; instead place the sutures but do not tie them until the third day if all goes well. This is primosecondary suture and it is by far the best form of treatment for ordinary wounds from any source. In wounds that are very deep or very ragged, the area is left wide open and no suturing of any type is used. (7) The *dressing element*—heavy gauze and cotton applications are used because rest and immobilization are important factors. If joints are contiguous, they should be splinted to provide additional immobilization; then the parts should be elevated and tilted if possible to promote drainage. (8) The *after-care element*—a sulfonamide is given by mouth, and our

practice at Pearl Harbor was to give 15 gr. of sulfanilamide each four hours for three days postoperatively. No redressings are done until the third day unless there are contraindications.

All redressings should be done with great care to avoid re-infection, hence a sterile clamp and thumb forceps should be used so that no soiled fingers or hands will contact the area involved nor touch any of the dressings. This is a blacksmith's technic because he uses tongs to touch his operative field and to handle his red hot material.

For the ordinary wound—the abrasions and scratches of the skin-deep variety—the routine is the same as far as the time element, the soap-and-water cleansing element and the powdering of the area with a sulfonamide are concerned. As to suturing this type, we may say that *primary or immediate suture* is permissible in recent superficial wounds that are well cleansed. However, the interrupted sutures should not be too numerous nor tight, and safety is added if a drain is inserted, such as a rubber band or a pipe cleaner. Drains, as a rule, should be removed within forty-eight hours.

However, in this superficial group if there is soil or débris contamination, the practice of primosecondary suture is best. As a matter of fact, the alignment obtained by this procedure is satisfactory enough even from a cosmetic standpoint.

The Infected Wound. These are the cases in which the pus-producing organisms or others have already established themselves. The typical signs such as pain, redness, swelling and systemic symptoms exist. Most cases are of the combined staphylococcus-streptococcus group. Less frequent are such invaders as gas gangrene and tetanus.

For the usual case manifesting pus secretion and cellulitis the treatment is:

(1) Provide exit for retained secretion by removing sutures if present.

(2) Apply wet dressings of 3 per cent sulfanilamide in water. Keep these moist by attaching tubes to a reservoir, and keep them hot by electric bulbs.

(3) When localization occurs, incision is indicated only if and when (a) local fluctuation, (b) local induration and (c) local pain exist. Let the incision be long enough and deep enough to provide self-gaping. For drainage use gauze only if bleeding is free or the edges have to be separated. Soak this gauze in 3 per cent sulfanilamide in mineral oil. Do not ram gauze into any wound; that is not surgery, it is taxidermy. Do not incise alone for such symptoms as brawny induration, redness, red streaks or adenitis. If we incise for these indications, we may increase and not decrease the process; and what is more, we may produce a blood stream invasion by our effort.

(4) Give a sulfonamide by mouth, 15 gr. every four hours for three days.

Gas gangrene involvement was treated at our Pearl Harbor formation by liberal débridement, repeated *x*-ray exposure and sulfanilamide in the wound and by mouth. We used serum in only a few of our eleven cases. All our wounded recovered without re-amputation, and in every case of this infection, sutures had been used. Tetanus yields usually to serum, but we must not forget that débridement and sulfanilamide locally and by mouth are necessary adjuncts.

In any infection, the combating and sustaining power of transfusion dominate the program.

Thus to sum up, we treat war wounds in terms of: (1) Time, (2) soap and water cleansing, (3) débridement, (4) primosecondary or no suturing, (5) sulfonamides locally and internally, (6) adequate dressings, (7) careful redressings, (8) blood for shock and infection, (9) no secondary incisions except for localization, (10) débridement, sulfonamides and *x*-ray for gas gangrene, and (11) antiserum for tetanus.

Just a word or two regarding substitutes for the proved-by-experience sulfonamides. We are beginning to hear of the earth-born derivatives called *pencillin* and *gramicidin* and these may prove in the future to be

potent weapons in our surgical war. But until these reinforcements arrive, let us rely on the ammunition that continues to render such valiant aid—the *sulfonamides*. We should take every advantage of these weapons that so effectively kill our germ enemies. Let safety first be our guide, and to that end suspect *every* wound of being hostile until proof to the contrary is demonstrated.

A PROPER examination after a pelvic injury should never omit inspection of a sample of urine (by catheter if none can be voided). If bloody urine is found, a catheter should be inserted and the bladder washed with salt solution. In this manner it can be determined if the bleeding comes from kidney, bladder or urethra.

From—"A Manual of the Treatment of Fractures"—by John A. Caldwell (Charles C. Thomas).

FRACTURES SUSTAINED IN WAR

WILLIAM DARRACH, M.D.
Attending Surgeon in Charge of Fracture Service, Presbyterian Hospital
NEW YORK, NEW YORK

THE treatment of simple fractures under war conditions differs in no way from their treatment in ordinary life. First-aid protection, early reduction and proper immobilization are the main indications.

According to the statistics of the last war as published by Love, the casualties of the U. S. Army showed that 54 per cent were soft part wounds of the extremities, 29 per cent were compound fractures of the extremities, 9 per cent involved head and spine, with involvement of chest and abdomen 1 per cent each. The compound fractures, therefore, are a most important group.

The pathological status of these compound fractures produced in war differs from that encountered in civilian life in several ways: There is much greater comminution. Instead of two or three fragments, an area of 5 to 15 cm. of bone will be completely shattered with a corresponding amount of soft part damage. With rifle or machine gun wounds the soft part damage and contamination may be minimal but in cases produced by shell and bomb fragments the damage is often extreme. The large, lacerated wounds contain bits of clothing and other foreign bodies. Another difference between the civilian and war problems is that of transportation, which has an important bearing on treatment. In civilian work the first trip the patient has may be long and difficult but once he arrives at a hospital he can receive his surgical treatment and then be kept quiet as long as may be necessary. Under war conditions treatment is often interrupted by several moves in the first few days and the treatment must be planned to meet this difficulty.

Even with these differences in the pathological condition, the fundamental principles of treatment of compound fractures sustained in war are the same as those encountered in civil practice. These principles are based on the facts that we are dealing with individuals who have received injuries to their bones and soft parts, with open wounds communicating with these injured areas and with contaminating material introduced into the depths of the wound. The Army Medical Corps can do nothing to control the extent of the original injury but it can do a great deal to reduce the amount of secondary trauma the wounded man is exposed to after he has been hit. The object of the first-aid treatment is to reduce this secondary trauma to a minimum. This involves protection of the wounds, early splinting and the use of chemotherapy at the earliest possible moment. The British Army in the last war reduced their mortality in compound fractures of the femur, from 50 to 15 per cent by the application of Thomas splints by the stretcher bearers. The reports from Pearl Harbor of the delay in the spread of infection by the early use of the sulfa drugs are most encouraging. The results of tetanus toxoid immunization promises even to surpass the efficacy of the use of antitoxin.

The second principle is the operative treatment of the wound at the earliest possible moment. In addition to the broken bone there is lacerated muscle and fascia, much of it damaged beyond repair. This dead and dying tissue furnishes ideal conditions for the growth and activity of the contaminating pathogenic organisms introduced into the wound. These must be removed by careful dissection and irrigation. Surgical cleansing of the wound, called débridement, needs extreme care and gentleness in order to lessen the secondary trauma and to avoid spreading the contamination to the deeper planes. Under

complete anesthesia and with traction maintained, the wound is protected by gauze while the surrounding skin is thoroughly but gently scrubbed with soap and water. The injured part is then draped and the excision of traumatized tissue and foreign bodies carried out with sharp dissection. This is done in layers with frequent change of instruments. At the same time the wound is irrigated with plentiful amounts of saline solution. Four quarts is a minimum amount. In irrigating the deeper planes, the sides of the wound are retracted and the nozzle introduced so that the flow will be from within outward. The object is to wash *out* the wound not to wash *in* contaminating material. The débrided tissue should be put into a sterile container for aerobic and anaerobic cultures to establish the character of the contaminating organism. On completion of the débridement, salt solution from the depths of the wound should be cultured to test the efficacy of the operation. The result of these cultures will be of help in deciding on the future treatment of the wound.

The next problem is to bring the bone fragments into normal alignment and to apply dressings to the wound. At this stage, one of the protective drugs is introduced into all the planes and crevices of the wound and the surfaces separated by vaseline gauze. Although some surgeons are of the opinion that these wounds can be closed if seen early and properly débrided, I believe strongly that they should be left open. Many successful primary closures are reported but when they are not successful the results are often calamitous. Tension within the wound favors bacterial growth. Which of the various sulfa drugs or zinc peroxide is the most efficacious for local use in these wounds is still a debatable point to be established by further experience. Apparently, if one of the sulfa drugs can be introduced into the wound as a primary dressing procedure and the oral administration started at the same time, the surgical treatment can be carried out with success at a much later period than if the drug is not used. Six to eight hours was formerly thought to be the safe period without the use of those drugs. With their use such treatment may be successful after even two or three days.

The next step in treatment is the immobilization of the injured part. This can be accomplished by traction and suspension, by circular plaster splints alone, by wire or pin traction, the wires or pins being incorporated into plaster or into some external appliance such as the Roger Anderson method or by rigid internal fixation by plates and screws. These various methods have been enumerated in the reverse order of their efficiency. Suffice it to say that the constantly repeated movement of the bone fragments during transportation and dressings is a large factor in the spread and continuation of infection.

SUMMARY

Compound fractures form a large percentage of war wounds. Although the pathological status is more complicated in war wounds, the principles of treatment are the same: (1) first-aid protection of wounds, early splinting, early use of drugs, (2) operative cleansing of the wound at the earliest possible moment, (3) reduction of fragments and (4) immobilization.

BRAIN INJURY IN WAR

FOSTER KENNEDY, M.D.
NEW YORK, NEW YORK

RECENTLY it has been proved experimentally by Denny-Brown that a head injury, in order to produce unconsciousness, must cause an acceleration of movement of the brain, either positively or negatively, to the extent of at least 28 feet per second. Such shaking of the brain usually does not occur if the skull is penetrated by a metal fragment going at high speed. Therefore, a man injured in this manner, if unconscious immediately, has usually been made unconscious, not by the impact of the missile but by the missile having ploughed through such an extensive area of brain tissue as to make it extremely unlikely that he can be saved. On the other hand, a nonpenetrating blow on the head will often produce immediate unconsciousness without necessarily having destroyed or perhaps even injured permanently any brain area. In fact, I have seen an officer suddenly go blind during the last war, who denied to me that he had been hit. All he knew was that daylight had been replaced by complete blackness. When I found the pupils fixed, I knew his blindness was organic, but I failed, in the trench, to find any sign of a wound on the scalp. Later, at the casualty clearing station, a tiny, crescent-shaped, red hairline was found above the hairline on the temple and *x*-ray examination revealed a minute sliver of steel placed squarely in the optic chiasm.

The size of entry in the skull is usually small and circumscribed; the inner table is apt to be shattered and bone fragments from it carried into the brain. The wound in the dura may be still larger by reason of both steel and bone fragments. The cortical vessels are torn; a hematoma may form along the track of the missile.

The treatment of these wounds has changed since the advent of sulfanilamide and its "cousins." I remember seeing more than thirty brain abscesses at a time in a single base hospital in the last war.

If brain injuries are treated early, it is possible now to prevent their infection. It is, therefore, important that head injuries be cared for near where they occur and a more or less routine procedure for their treatment can be produced.

Procedure of Treatment. (1) The hair should be clipped and the scalp washed with soap and water. (2) A local anesthetic, such as procain hydrochloride, should be used; do not use morphine. (3) Large vessels should be caught with hemostats or by rubber tubing placed around the forehead. (4) Wounds should be filled with sulfanilamide or sulfapyridine; débridement should be effected as well as possible. (5) Antitetanic serum should be given. (6) Treatment for shock should be instituted immediately and operation ought to be delayed for twenty-four to thirty-six hours. Patients should be sent back to where *x*-ray facilities are available and then operated upon. Such a "head station" should be as near the front area as is militarily possible.

If the injury is treated early, the wound promptly filled with sulfanilamide and if it is not too large, the patient will probably survive.

It is now possible to treat such patients with a closed operation, the scalp being undercut and closed with interrupted sutures. For hemorrhages from dural vessels mosquito clips are best; avoid the cautery for these. The dura should be closed with a periosteal patch, especially if paranasal sinuses are involved. Suck out the blood clot in the track of the missile and irrigate with warm saline. Exploration is best carried out, not with the finger, but by means of a rubber catheter as Cushing taught us. Any wound big enough to be explored with the finger is hardly worth

exploring. Finally, the track should be filled with sulfanilamide powder before closure. Do not be too squeamish about leaving inaccessible bone or metal fragments. One may do more harm by taking fragments out than the enemy did by putting them in.

After this procedure, sulfanilamide drugs should be continued. Luminal therapy should be started at once and an instruction tagged on the patient that luminal should be continued for a year more, because of the possibility of convulsions appearing within twelve or fifteen months.

If the wound has to be reopened for drainage, gauze impregnated with sulfanilamide or sulfapyridine should be used. On the whole, in these cases sulfapyridine is to be preferred to sulfanilamide as it has proved to be less depressing to the brain cortex.

If by the mischance of war or poor management the wound has not been treated in the manner described within forty-eight hours, it must be treated as an infection, that is, an open wound, as was habitual in the last war.

Since the effect of rapid closure is to produce increased pressure and acute cerebral edema, one must be prepared to deal with these by dehydration measures, including 50 per cent sucrose solution, caffeine, sodium benzoate, and if available, concentrated serum, given intravenously. This concentrate is prepared by adding 40 cc. of sterile distilled water to the dry solids obtained from 200 cc. of human serum, shaking well and incubating for one hour at blood temperature. Serum obtained from pooled blood requires no blood grouping. It is recorded that in one case pressure fell from 275 to 80 mm. within twenty minutes after the use of concentrated blood serum, rising later to a normal level of 110.

Although in the last war the mortality rate after brain injury was said to be 60 per cent, I myself thought it was more. I saw somewhere that Cushing by means of his technic had lowered it to 28 per cent, but this was probably only on his own cases.

I remember, just after the battle of Messines Ridge, I met Sir Anthony Bowlby on a road near where Cushing had been provided with a "head hospital." I asked General Bowlby how Colonel Cushing was doing, and he replied enthusiastically, "He is doing beautiful work, but he has only done 8 cases in a day. We shall have to ring the Germans on the telephone and ask them to call off the war to give Cushing time to catch up!" We must remember always, in making our plans, that there is a war on. One must work fast when convoys of wounded are pouring in, perhaps under fire, and orders to evacuate may come in the middle of an operation; so, one must be swift to change methods.

In basal fractures, it is well to remember that the dura is firmly attached to the basal portion of the skull and, therefore, is nearly always torn. There is danger in these cases of the fracture being compounded into the nose, ear or accessory sinuses, with subsequent risk of infectious meningitis. If an *x*-ray can be taken and discloses intracranial air, the compound nature of the injury is proved. I once saw a lady in Paris who fainted suddenly, falling forward on her forehead. She was immediately unconscious. When an *x*-ray was taken a perfect ventriculogram was found; a fracture of the posterior wall of a frontal sinus had allowed air to whistle into the cranial cavity, fill the ventricles to distention, so that at the American Hospital she was accused of amnesia for a recent lumbar puncture with air injection.

All cases of stiff neck do not necessarily signify infectious meningitis, since this may be produced through seepage by gravity of subarachnoid blood. If one has the chance of doing a lumbar puncture to establish the presence of blood in the spinal fluid, this should be done, except in those cases in which leakage of spinal fluid from the nose, ear or sinuses, or bleeding from the ear or nose have demonstrated the presence of basilar fracture.

The tomograph, an instrument by which roentgenologists can visualize and localize

structures and foreign bodies in three dimensions, should be part of the equipment of every base hospital. The use of electric magnets for the extraction of fragments was common in the last war, and I understand is still being used, but this is a base hospital operation and has its limitations.

The following are a few suggestions: (1) The bladder of any unconscious patient should be closely watched. (2) Sulphur containing drugs, like epsom salts should not be used if sulfanilamides have recently been given. (3) Where flying ambulances are used, patients who are receiving sulfanilamides or related drugs, should not be transported at high altitudes, lest sudden death occur from lack of oxygen. (4) Patients with compound fractures into the nose must be instructed not to blow the nose. (5) When burns occur, hydrosulfosol may be used as a spray; diluted 1:20 it may even be used for the eyes.

At the beginning of this paper, I have tried to outline a procedure for penetrating head injuries. I should like, in conclusion, to add a similar outline for the care of non-penetrating head injury: (1) Treatment of shock by the intravenous injection of 100 cc. of 50 per cent hypertonic glucose solution or blood serum as already described; (2) lumbar puncture for diagnosis and treatment; (3) repetition of hypertonic dextrose by vein to reduce increased intracranial pressure (100 cc. of 50 per cent solution, three times daily); (4) injection of caffeine sodiobenzoate, 7½ gr. (0.5 Gm.) every four hours (hypodermically); (5) rectal taps of 25 per cent solution of dextrose, 4 ounces (120 cc.) every four hours; (6) elevation of head of bed 15 to 45 degrees; (7) the carrying out of operative procedures in cases suspected of progressive middle meningeal hemorrhage; (8) the use of antimeningococcic serum in suitable cases and antitetanic serum in all patients with a scratch on them; (9) the performance of right subtemporal decompressions in comatose patients with marked papilledema, who do not respond to the aforementioned procedures within three days; and (10) uncomplicated depressed skull fractures may be elevated after the acute stage of shock has passed. Surgical interference in this group may often be safely postponed for many days.

OUTLINE OF TREATMENT FOR SEVERE WAR WOUNDS OF THE CHEST

HAROLD NEUHOF, M.D.
NEW YORK, NEW YORK

WOUNDS of the chest related to bombing offer no special surgical problem because the devastating effects of hurled fragments of glass or stone are analogous to those of flying fragments of high explosives. Although the character of chest wounds thus remains essentially unchanged from that of the first World War, considerable difference in treatment should be anticipated because of the advances in thoracic surgery in the intervening two decades. The advances have been in three principal directions: (1) a better understanding of cardiorespiratory physiology, (2) positive pressure anesthesia, particularly with the newer anesthetics and (3) the technic of removal of large sections of pulmonary tissue. In this outline of management of thoracic wounds I propose to indicate the part which I believe these advances should play.

As in other serious wounds, the effects of shock and hemorrhage often are to be combatted in the initial phase. There are two features inherent in all serious thoracic wounds which create special problems: (1) the agitation of a rigid yet constantly moving bony cage, and (2) the likelihood of interference with the function of the heart or the lung, or both. Significant effects of the severer injuries can be briefly enumerated: (1) air in the pleural space with or without blood, (2) bleeding into the pleural space which tends to continue if the lung collapses, (3) sucking wound with increasing intrapleural tension and mediastinal shift and (4) bleeding into the pericardial sac and cardiac tamponade.

Diagnostic questions are here omitted yet emphasis should be placed in season and out of season on the fact that grave damage may result from an apparently insignificant penetration or, put in another way, an insignificant penetration has usually inflicted grave damage if shock has been induced.

The surgical management of a serious thoracic wound should be related to the time and place of first treatment, the urgency of the case and the availability of special personnel and equipment. General treatment will not be considered. The primary requirements for the local lesion are: (1) morphine, regardless of a possible untoward effect on cough or respiration, (2) for a sucking wound, tight packing and strapping and (3) for hemorrhage from the thoracic parietes, tight packing of the entire tract in the chest wall. Incomplete emergency operations, such as the suturing without débridement of a sucking wound, are to be deplored. If the patient is suffering from tension pneumothorax after emergency packing of the wound, the trapped air should be at least partially withdrawn by any available means. When, however, tension pneumothorax is due to a laceration of the lung, resort must be had to a continuous evacuation of the air. There are two excellent methods for this purpose: closed drainage under water into a bottle situated considerably below the level of the chest or, especially for a patient to be transported, an intercostal tube with attached flapper valve as devised by Lilienthal.

An urgent condition which calls for immediate surgery whenever possible is ciardiac tamponade due to a penetrating wound of the heart. In addition to the picture of shock its evolution is characterized by a progressively smaller pulse with corresponding drop in the blood pressure, distended veins in the neck, and a silent heart. The absence of cardiac pulsation, which is the essential operative indication, can be established unequivocally only by

fluoroscopic examination. Lacking such confirmation, and in the absence of specially trained medical personnel, nonoperative treatment is probably safer.

Indeed, specially trained personnel (surgeon and anesthetist), as well as special anesthesia equipment are eminently desirable for all major primary thoracic operations. If not available, I believe that routine conservative treatment, which was generally practiced and yielded a measure of satisfactory results in the first World War, is in order. Makeshift operations or operations by those without experience should have no place in this field. Given a trained operating team, thoracic wounds in general offer an unusually favorable field for early and complete recovery, much more favorable than cranial or abdominal wounds, for example. The objective should be the restoration of cardiac function and full expansion of the lung. There is thus avoided the intrathoracic crippling which is prone to occur from organization of retained blood clot and exudate. Indications for a primary operation by a trained team are (1) continuing hemorrhage, (2) the definitive closure of an open pneumothorax, (3) laceration of the lung, (4) removal of foreign bodies, and (5) a wound of lung and/or of chest wall requiring débridement.

Positive pressure anesthesia is imperative for primary intrathoracic operations, in my opinion, because expansion of the lung is to be achieved from the outset if possible. Cyclopropane is a particularly desirable anesthetic in this field. Intratracheal anesthesia has been recommended but appears to me to be unnecessary even for the most extensive operations. Positive pressure anesthesia with the customary mask makes possible the safe opening of the thoracic cavity to any desired extent. The removal of foreign bodies and débridement of the lung are facilitated by at least partially controlled respiration (carried out by the simple expedient of rhythmic pressure on the bag). Extensive pulmonary lacerations may required partial or complete lobectomy or even pneumonectomy. Scarcely any primary thoracic operation would be terminated today without pleural poudrage with one of the sulfonamides. Most thoracic wounds should be completely closed; when accumulations of air or blood are to be anticipated, closed under-water drainage toward the bottom of the chest is a safety measure. Special requirements after operation may be (1) the administration of oxygen by means of a mask, (2) bronchoscopic suction which may be life-saving in cases of accumulated secretion in bronchi and bronchioles, and (3) the control of abdominal distention chiefly by the passage of a Levin tube.

Turning to the question of the treatment of major thoracic wounds which do not require primary operations, many perforating rifle bullet wounds, for example, the chief problem is the management of hemothorax. The simple withdrawal of fluid is advocated by some, with the addition of air replacement by others. In either case it should be noted that prolonged retention of blood may lead to crippling peripulmonary fibrosis, to pleural infection, or to both.

While primary operations deal with recently inflicted wounds, secondary operations are concerned essentially with infections in the pleural space. Single encapsulations of pus are unusual. Therefore, careful preoperative study of *x*-ray films are necessary in order to locate the foci of infection which will be encountered. A liberal operative exposure will usually be required. The problem of traumatic pulmonary abscess, whether due to infection, to foreign body, or to both, requires special consideration particularly from the viewpoint of precise localization in order to achieve accurate surgical approach. Some aspects of nonpenetrating wounds of the chest, a subject which has not been touched on, can be referred to only in passing. An atelectatic pneumonia may result from a contusion of the chest wall. Fractured ribs may tear the lung with resultant tension pneumothorax

or mediastinal emphysema. Crushing chest injuries often are characterized by the lividity of traumatic asphyxia and at times by extreme dilatation of the stomach. A special feature of the present war is the remarkable and horrible "blast injury" of the chest producing extensive hemorrhages into the lungs. These pulmonary lesions apparently are due to concussion or commotion, for there may be no external injury. The striken individual is in shock, with dyspnea and cyanosis, suffers thoracic and abdominal pain, and presents abdominal rigidity not accounted for by other injuries.

In the allotted space only injuries limited to the chest have been considered. In closing, reference should be made to concomitant wounds which may require procedence in treatment, and finally, to thoracico-abdominal or abdominothoracic wounds, often of grave significance, in which the abdominal component may and often does require more urgent attention.

THE clavicle is one of the bones most frequently broken. The most common site of breakage is at the junction of the outer and middle thirds where the diameter of the bone is smallest. . . . The fracture is apt to be oblique, rather than transverse.

From—"A Manual of the Treatment of Fractures"—by John A. Caldwell (Charles C. Thomas).

SURGERY OF ABDOMINAL INJURIES*

CHAS. GORDON HEYD, M.D.
Professor of Surgery, New York Post-Graduate Medical School, Columbia University
NEW YORK, NEW YORK

THE imperative necessity for an army is to conserve and maintain an effective fighting force. The treatment of war casualties will be based largely upon this realistic conception. Wounded soldiers will have received: (a) injuries of such a nature that the army may reasonably expect his return to duty, and (b) injuries of such a nature that the soldier cannot be expected to return to duty. War trauma to the skull and contents, to the chest, grave compound fractures and injuries to the abdomen will be treated without any expectation of the return of the soldier to a combat unit.

The last forty years has witnessed a remarkable change in regard to surgical intervention for war wounds of the abdomen. In the Boer War, the Spanish-American War, and for the first half of World War I, the noninterventionist attitude for abdominal war wounds prevailed. However, with the ability to move modern operating room equipment into the battle zone the interventionists gradually displaced the noninterventionists.

The remarkable advance in modern warfare has introduced types of injuries that were only occasionally met with in World War I. The weight of projectiles and tempo of bombing, added to the dive bombing machine gun attacks have broadened the type and severity of injury. Present day bombs create innumerable secondary projectiles from fragmentation of anything that is in the path of the explosion. Two types of projectiles are thus created: the metal part of the shell, which is jagged, rough and of various sizes, and the secondary projectiles of rubble, metal, glass, and in fact anything and everything that may be activated and put in transit by the explosion of the bomb. Both carry into the body tissues additional foreign material in the form of clothing and underwear.

In no field of war casualties is the problem of surgical organization so important as in multiple compound fractures, injuries to the skull and contents, thoracic wounds and abdominal wounds. Therefore, surgical organization will imply mobile units that will bring modern operating room technic and equipment into the combat area. These types of war wounds are considered "non-transportable cases" and hence the effectiveness of small, self-contained surgical units, with great mobility, capable of competent surgery within the battle zone.

War casualties of the abdominal viscera are always multiple and severe, always associated with some degree of shock and hemorrhage and many patients will be exsanguinated; all will be complicated by a peritonitis of varying degree and 90 per cent will be associated with perforation of one or more of the viscera. The patients must be transported from the casualty area to the surgical unit. It is obvious that the soldier with minor injuries of the trunk and upper extremities will be able to walk from the battle area to the advanced medical post, while those that are injured in the abdomen will lie upon the battlefield until stretcher bearers arrive to transport them. Except for casualties the result of bombing and aeroplane machine gunning, the field of battle will obviously have to be cleared by an advance of the combat units before the abdominal cases can be picked up and carried back to the most advanced dressing station.

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The surgery for war inflicted abdominal injuries is the application of technical procedures that are in no way different, except in degree, from the principles utilized in civilian traumatic surgery. The fundamental "technics" that are used in civilian surgery on the stomach, intestine and colon are the same surgical procedures that must be applied to the treatment of abdominal injuries sustained in war. These patients will all require adequate preoperative treatment, long anesthesia, relatively prolonged operations, extensive technical procedures, antiperitonitis measures, plus sulfa drugs locally and by mouth; transfusion of whole blood and plasma and parenteral fluids. Furthermore, they will require prolonged hospitalization and postoperative treatment.

The time interval between the receipt of injury and operation and the adequacy of preoperative treatment will determine the mortality. The optimum time for an advanced surgical unit to receive abdominal casualties would be up to four hours and not later than six. There is very little gross soiling of the abdominal cavity even in penetrating wounds of the intestines up to four hours, and there is a relatively slight degree of peritonitis. The patient with an abdominal injury will reach the casualty receiving station: (1) moribund and dying; the indications here are to relieve pain and thirst, (2) in shock, but capable of resuscitation and (3) in fairly good operable condition. A warm body is one of the most reliable objective signs of operability. Refrigeration on the battlefield or in the ambulance during the trip back to the casualty receiving station, combined with shock and physical collapse due to the gravity of the injury and loss of blood, is an almost fatal combination of circumstances. The patient may be suffering from an internal hemorrhage and the only hope of stopping the hemorrhage will be by operative intervention, with simultaneous blood replacement.

Mortality is inversely proportioned to the "time interval period," that is, the time between the receipt of the injury and the time of operation. Shock, hemorrhage and peritonitis are the outstanding causes of death.

The relative trajectory of the projectile may be visualized in many cases by an examination of the wound of entrance and exit if and when both are present. Deflection of the projectile is to be expected in injuries received in the area of the buttocks or from the thigh upward. The projectile will be deflected and its course deviated by hitting bone or penetrating the bony pelvis. The position of the patient, standing, squatting or lying, the status of the bladder in regard to its fluid content, will also determine the extraperitoneal or intraperitoneal injury of the bladder and rectum. Every patient upon whom a laparotomy is contemplated should be catheterized just before operation as it subserves two purposes: To indicate roughly an injury of the urinogenital system or the absence of urine in the bladder, and finally to have a collapsed bladder during the laparotomy.

The operative indications are more simple than the procedures that will be employed. Every abdominal case in fair operable condition requires surgical intervention. No wound of the external abdominal parieties should be considered insignificant. A projectile may go through five or more loops of bowel and pass through or lodge in the solid viscera. A projectile may not enter the peritoneal cavity but nevertheless produce widespread intra-abdominal injury by the force of impact. Every operation for an intra-abdominal war injury should be undertaken as a complete abdominal exploration.

War injuries of the abdomen may involve one or more of the abdominal viscera. They are usually associated with injuries of the thorax, retroperitoneal tissues including kidney, and with the extraperitoneal portions of the rectum and bladder. Ten per cent of the injuries of the thorax will be complicated by injury to the upper abdominal viscera. Combined thoraco-abdominal injuries passing from side to side

or from the right or the left side, are relatively benign. The projectile may pass through both sides of the costophrenic sinus, traverse the liver on the right side, or the spleen on the left, producing a variable amount of damage to these organs but not perforating the intestine or stomach. Wounds of the stomach will be complicated by injury to other viscera in at least one-third of the cases. Twelve per cent of abdominal injuries will have an associated injury to the diaphragm and chest; 10 per cent will be associated with an injury to the kidney; 10 per cent of injuries to the liver will be associated with injury of other abdominal viscera. The bladder will show a concomitant injury in 5 per cent of the cases and the spleen in approximately 6 per cent. War injury of the large bowel will carry with it a higher mortality and 40 per cent will be associated with injury to other abdominal viscera. The incidence of injury to the retroperitoneal tissues is high whenever the colon is injured. Infection of the retroperitoneal tissues is severe and rapidly fatal due chiefly to the virulence of the aneorobic flora that arises from the colon. The exploration of the colon must be particularly thorough.

The presence of a considerable quantity of free blood in the peritoneal cavity suggests that a main vessel has been injured. Every injured viscus will bleed, the liver and spleen, in great degree, and the finding of a large amount of blood makes it imperative to locate the source of the bleeding at the very beginning of the laparotomy. The abdominal viscera should be explored systematically: (1) the small intestine, (2) the colon, (3) spleen, liver and stomach, and (4) bladder and rectum. All of the small intestine should be inspected from the angle of Treitz to the cecum before any attempt is made to repair the perforations. As each perforation is encountered it should be occluded temporarily by rubber compression clamps for it may happen that five, six, seven or more perforations are all within two or three feet of bowel and one resection will be better than the consecutive closure of a variable number of perforations.

The detachment of the mesentery at its attachment to the small intestine of more than 5 cm. will almost inevitably result in death of that portion of the bowel. Aseptic resection with blinding of the ends and then a lateral anastomosis will be the safest procedure as it is estimated that a lateral anastomosis provides about 10 per cent greater safety than end-to-end anastomosis. In general, the closure of intestinal perforations by enterorrhaphy is attended with less mortality than resection. The danger of a subsequent postoperative intestinal obstruction is not great as a small bowel lumen will suffice for the passage of the fluid contents of the small intestine. If any doubt arises at the time of operation in regard to patency after enterorrhaphy, a lateral anastomosis may be easily and safely performed.

In wounds involving the lateral and anterior abdominal wall the best practice is to complete the laparotomy first and then give attention to the entrance and exit wounds. These wounds should be completely resected by mass excision of the tract with a surrounding area of healthy tissue from the surface of the abdomen through the muscular parieties into the peritoneal cavity. The most practical incision is a midline incision. This incision may be extended either up or down, or laterally, and provides an excellent exposure except for the extraperitoneal portion of the rectum which should be explored by a parasacral incision.

Every injury received in or about the region of the buttocks must be suspected of having injured the extraperitoneal and sacral portion of the rectum. All wounds involving the posterior portion of the trunk and buttocks should receive surgical attention before the laparotomy and not afterward. The turning over of a recently laparotomized patient to take care of posterior wounds is attended with a sudden, pronounced return of shock.

Shock and resuscitation will be reduced by timely and adequate preoperative treatment. Sedation, water balance, whole blood and plasma transfusions will return many patients to a fairly operable condition. Peritonitis, retroperitoneal infection and gas infection will be combatted by the administration of the sulfa drugs by mouth or intramuscularly and by local application. Death from hemorrhage may be prevented by prompt transportation, adequate preoperative treatment and timely surgery.

The effectiveness of abdominal surgery for war casualties and the final outcome of the salvage of lives will depend largely upon the organization of the advanced surgical units that must take care of the grave nontransportable casualties. Low mortality will depend upon (1) available transportation and accessibility for transfer in and out of the combat area, (2) well trained ancillary groups for the treatment of shock and hemorrhage. These terms will be concerned with preoperative preparation—the treatment of shock—the giving of whole blood or plasma transfusions and parenteral fluids, (3) a highly trained, experienced operating unit of individuals that have worked together over considerable periods and (4) sufficient facilities for the longer hospitalization after operation than obtains in the other fields of war surgery.

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THE POTENTIATION OF THE SULFONAMIDES IN THE LOCAL THERAPY OF WOUNDS AND SURGICAL INFECTIONS BY THE USE OF OXIDANTS*

HAROLD A. GOLDBERGER, M.D.
NEW YORK, NEW YORK

ALTHOUGH it is more than thirty years since Gelmo[1] synthesized sulfanilamide, and almost ten years since Foerster's report,[2] only seven years have elapsed since Domagk[3] published his classic contribution which has signalized a new era in medicine. In this comparatively brief interval there have been more than two thousand references concerning this new series of chemotherapeutic agents. Literature, however, up to very recently, was marked by the paucity of reports concerning topical use in surgery. The writer has been, for the past ten years, particularly interested in problems of wound healing and in management of surgical infection. Shortly after Domagk published his classic, we reported on the use of the chlorine antiseptics of low potentials.[4,5,6] It was quite natural, then, to turn our attention to this remarkable compound and investigate its usefulness in the management of wounds. Thus, for several years, we have been concerned with the study of the local application of various sulfonamide drugs in the search for the most effective means of utilizing their remarkable antibacterial powers.

At the onset of this work, several questions presented themselves: Are the sulfonamides effective in local wound therapy? Is healing inhibited *per se* by the sulfonamides? Are the sulfonamides absorbed into the general circulation when applied locally to wounds? What is the most effective means of applying these drugs? What is the rationale for the most effective mixture? What are the indications and limitations to their use? Are idiosyncrasies encountered? What is the mode of action?

This study covers several years' observations, during the course of which we were compelled to overcome the desire to report our findings, by the greater desire to confirm by repeated observations, the conclusions which we believe are now amply substantiated.

LITERATURE

At the inception of this study we could find but few references to the local use of the sulfonamides. Amongst them were Jaeger,[7] Sinclair,[8] Jensen et al.,[9] and Bohlmann.[10] Little, if anything, of significance was uncovered except for that found in Jensen's paper. This report of good results obtained in thirty-seven out of thirty-nine cases of compound fractures in which 5 to 15 gm. of sulfanilamide had been placed in the wound may be considered the first significant report; we have been unable, however, to confirm the high concentration (up to 800 mg. per cent) they obtained in the local fluid. Bohlmann, earlier, in 1938 used sulfanilamide orally in surgical cases with favorable results but found no brief for his attempt at local application. As competent an observer as Lockwood[11] in October, 1940, reviewing the possibilities of sulfonamide therapy in surgical infections, surveyed the field with hardly any mention of local use. Thus we entered an almost virgin field for the cultivation of our ideas in local application of the sulfonamides. The main thesis of this paper suggested itself early, particularly in the light

* From the Department of Surgery, New York Dispensary and the Fourth Surgical Division, Bellevue Hospital.
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of our previous experience with a chlorine agent in wound therapy.

During the past two years, with the stimulus of war casualties, more attention has been drawn to the local use of the sulfonamides. The British surgeons lately have been particularly concerned with the possibilities in this mode of therapy. Buttle[12] found that sulfanilamide applied directly to the wound will be eliminated in two to three days and advised oral medication with it. He stated that no other antiseptic should be applied. Key and Burford[13] found no retardation of experimental fracture healing when sulfanilamide was implanted. Herrell and Brown[14] reported favorably on its use in infected wounds and noted that the higher local concentrations were more effective than those obtained by oral use, with their subsequently low blood levels. They suggested the use of 30 gr. of sulfanilamide to 100 cc. of normal saline as an irrigation. Stuck et al.[15] found its use effective in compound fractures as did Thomson[16] who advised it in conjunction with oral chemotherapy and designated it as a "Sixth Commandment" for the treatment of compound fractures. Eisenhamer[17] applied it in teaspoonful amounts to joint capsule and other wounds in war casualties. Mayo[18] used solutions of sulfanilamide as an irrigation for wounds. Other investigators[19–22] confirmed the favorable results in compound fractures.

The intraperitoneal use of sulfonamides in peritonitis and appendiceal abscesses has become, by this time, a common procedure. Five to 12 Gm. of the sterilized powder are placed in the peritoneal cavity. Dees,[23] Mueller,[24] Rosenburg and Wall,[25] Thomson et al.[26] and others have reported success in this manner. Hawking[27] made an excellent contribution in his investigation of experimental gas gangrene and indicated sulfathiazole as the most effective agent. Bonnon and Fenner[28] have reported indications for the local use of sulfanilamide in prophylaxis of this type of infection. Casberg[29] implanted crystals in eighteen cases of herniorrhaphy and noted no infection or retardation of wound healing. Johnson and Davis[30] applied sulfanilamide to a variety of wounds with diminution of complicating infection. Cosgrove[31] applied sulfanilamide locally to the eye in normal saline with no evidence of irritation in the treatment of trachoma. Guyton[32] used sulfanilamide as an ophthalmic ointment in the treatment of corneal ulcers.

Dental surgeons were among the first to recognize the value of the local application of sulfanilamide. The local use of sulfanilamide in dental surgery has been reported by Sinclair,[8] Dent,[33] Ziegler[34] and others.

In 1939, when our studies were initiated, we could find but a handful of references to the local use of sulfonamides. The year, 1940, however, found perhaps seventy or more papers on this subject. It is safe to say that this field of chemotherapy will constitute an invaluable addition to the surgeon's armamentarium.

The mode of action of the sulfonamides, either locally or systemically, was, and is, a controversial topic. The comparatively low *in vitro* activity of these agents, when compared with many germicides and antiseptics of surgical practice, early suggested that they operate on an entirely new principle and that they had nothing in common with agents formerly used in combatting infection. The appearance of this new principle in therapy suggested to the writer the wisdom of combining both methods of attack—the new and the old—use of an antibiotic sulfonamide compound simultaneously with accepted agents having antiseptic properties in the ordinary sense.

The clinical results, over an extended period of observation, during which approximately a hundred sulfonamide-plus-antiseptic mixtures were employed, showed a clear-cut differentiation between preparations which gave the more or less anticipated results and those which excelled and exhibited a potency that cannot be easily explained upon a basis of purely additive effect.

Scrutiny of these antiseptics which appeared to contribute to the sulfonamide

preparation more than their expected antiseptic values revealed these agents to be, in almost every instance, oxidizing substances. The enhanced effect which they produced in a sulfonamide-treated wound was soon substantiated by *in vitro* experiments. The augmenting effects, moreover, were found to be exerted even by concentrations far below antibacterial levels of the substances if used alone. The antiseptic agents employed during the process of the investigation were of many classifications. (Table I.)

Table I

1. Halogens
   - *a. Iodine
   - *b. Azochloramid
   - *c. Di-chloramine T
   - d. Thymol iodide
   - e. Iodoform
2. Organic mercurials
   - a. Metaphen
   - b. Merthiolate
   - c. Mecresin
   - d. Mercurochrome
   - e. Phenyl mercuric nitrate
3. Quinones, quinolins
   - a. Hydroxyquinoline sulfate
   - b. Quinoline
   - c. Hydroquinon
   - d. Vioform
4. Phenols
   - a. Phenol
   - b. Hexylresorcinol
5. Peroxides
   - *a. Hydrogen peroxide
   - *b. Zinc peroxide (ZPO special)
   - *c. Benzoyl peroxide
6. Miscellaneous
   - a. H-1 (extract of soil bacteria)
   - *b. Potassium permanganate

* Oxidizing agents.

CLASSIFICATION OF LESIONS TREATED

We were fortunate in having a large series of cases for study, particularly so because, with only few exceptions, all treatments and observations were made by one individual. This is of more than passing significance where repeated observations are necessary to confirm conclusions. Our cases may be classified as shown in Table II.

TRAUMATIC LESIONS

This group of wounds may be subdivided into those receiving early and those delayed, treatment. Wounds were con-

Table II

CLASSIFICATION OF LESIONS TREATED

		Cases
I. Abrasions (Preparations Nos. 15, 48, 90)		37
(a) within six hours	11	
(b) six hours or more	26	
II. Lacerations (Preparations Nos. 2, 15, 83)		
(a) within six hours		67
(1) scalp	28	
(2) face	16	
(3) extremities	23	
(b) six hours or more		69
(1) scalp	31	
(2) face	24	
(3) extremities	14	
III. Avulsed wounds (Preparations Nos. 15, 40)	19	19
IV. Puncture—stab wounds (Preparations Nos. 2, 15, 81)	22	22
V. Foreign bodies—exploratory wounds (Preparations Nos. 2, 15, 43, 83)	26	26
VI. Operative wounds (Preparations Nos. 2, 15, 26, 43)	162	162
VII. Hand infections (Preparations Nos. 15, 16, 43, 81, 83)		182
(a) epiparonychia	56	
(b) subepithelial abscess	15	
(c) subungual abscess	24	
(d) dorsal phlegmon	18	
(e) anterior closed space infection	32	
(f) flexor sheath infection	9	
(g) fascial space infection	12	
(h) osteomyelitis	16	
VIII. Morsus humanus (Preparations Nos. 15, 40, 43, 81)		11
(a) within six hours	5	
(b) six hours or more	6	
IX. Abscess cavities (Preparations Nos. 2, 15, 40, 43, 81)		112
axillary, breast, Bartholin, subcutaneous, ischiorectal, etc.		
X. Carbuncles (Preparations Nos. 15, 40, 48)		12
XI. Burns (Preparations Nos. 15, 89, 90)		23
XII. Leg Ulcers (Preparations Nos. 15, 26, 40, 81, 83, 90)		56
XIII. Miscellaneous		84
(a) bronchopleural fistula		
(b) osteomyelitis		
(c) suppurative olecranon bursitis		
(d) suppurative prepatellar bursitis		
(e) infected branchial sinus		
(f) dog bites		
(g) vaginitis, cervicitis, etc. (Preparations Nos. 15, 60)		
(h) otitis media, suppurative sinusitis (Preparation No. 15)		
(i) rectal, colonic infections (Preparation No. 99)		
(j) skin—		
pyodermia, impetigo, furunculosis, etc. (Preparations Nos. 15, 48, 90)		
fungus infections—(Preparations Nos. 17, 81)		
Total		884

sidered recent if they were received for treatment within six hours.

Therapy consisted in cleansing and shaving the skin. Tincture of green soap scrubs were employed. The wound itself was then thoroughly flushed with saline and hydrogen peroxide solutions. Where necessary, indicated surgery such as ligation of vessels or repair of severed structures was performed. Devitalized tissues, skin edges, etc., were débrided. Puncture wounds were laid open by unroofing, using criss-cross incisions with elevation of each of the four segments.

In lacerations which required sutures following the peroxide flushing, the depth of the wound was insufflated with the powdered sulfonamide or sulfonamide mixture prior to suture. Of these wounds, a series was insufflated with sulfanilamide or sulfathiazole alone, and another with a mixture of the two powders in the proportion of two parts of sulfanilamide to one part of sulfathiazole. A third group was insufflated with a powder composed of sulfanilamide, sulfathiazole and zinc peroxide in the ratio 4:2:1. Sutures were then applied in the usual manner and a dressing of gauze impregnated with one of the sulfonamide mixtures was applied after the wound margins had again been lightly dusted with the powder. One purpose of the study of this group was to determine whether or not the sulfonamide drugs exhibited any inhibition to wound healing; it is realized that many of these lesions, with adequate surgical care and preparation, might have gone on to primary union in the absence of any sulfonamide medication.

There was no appreciable interference with the rapidity of healing of the wounds treated in this manner as compared with the technic formerly used without the sulfonamide drugs. Not only could we observe no inhibition to healing, but we have not encountered a single wound infection throughout the entire series of sutured wounds thus treated. These included several late and extensive lacerations for which ordinarily the surgeon would not attempt primary repair.

To cite a case in point, the following report is presented:

A white male of thirty-six years, who, during a street brawl, was struck and caused to fall in such a manner that his ear was torn by the loose chain of a fire hydrant. He was brought to the clinic after lying some time in the gutter. There was a heterogeneous mixture of blood, skin, cartilage and dirt. After a gross cleaning with tincture of green soap and sterile water, the skin edges and lacerated cartilage were débrided. The entire area was flushed with hydrogen peroxide. All of the cut and repaired surfaces were then liberally packed with sulfonamide powder. Reconstruction was then attempted and some thirty sutures were required. The cartilage was approximated by several deep buried silk sutures and the skin edges were similarly repaired. The external dressing was of sulfanilamide two parts and sulfathiazole one part in triacetin (glyceryl triacetate) containing compound iodine solution 1:5,000. Primary union was obtained. Sutures were removed at the end of six days with an excellent cosmetic result.

A point to observe in this particular case was, that in a grossly crushed and dirty wound, contamination was overcome by the use of sulfonamide mixtures and, what is equally important, there was no evidence of any interference with the normal process of wound healing. (Figs. 1 and 2.)

Veal and Klepser[35] reported an impression of delayed healing in sulfanilamide treated wounds, which they believe may be overcome by the addition of a "stimulating agent." Although there appears to be evidence of a slight foreign body reaction locally, we cannot agree that the sulfonamide, thus applied, appreciably inhibits healing. Key et al.[36] report a slight retardation but state that it is not extensive enough to prevent use, even in clean wounds.

One of the simplest and perhaps the commonest of traumatic wounds is the simple abrasion. This, of course, may vary in degree and depth and in area involved. Needless to say, in most cases, simple

cleansing of the part with soap and water is sufficient. Fresh abrasions of this type were seen only when they were rather extensive; otherwise, for the most part, the patients neglected them until the time that they may have become infected. Sulfonamide powders or ointments were applied to these wounds and our observations indicate that they form, with the secretion, a coagulum which became dried and incrusted, depending upon the period of time elapsing between application and subsequent dressing. If left undisturbed for six days or more, healing was found, in most instances, to have taken place without any difficulty beneath this protective crust.

Puncture Wounds, Stab Wounds. Puncture and stab wounds, such as those produced by stepping on nails, also other lesions of this type, were treated by criss-cross incisions and unroofing of the inverted skin edges. Powder was packed into these wounds. It was in several instances that, due to the very configuration of the wound and the small amount of available wound surface, the powder was not absorbed readily and acted as a plug. It is advisable, therefore, not to use the powder in small puncture wounds unless, after six hours, the dressing is moistened and kept moist with saline solution.

Avulsed Wounds. Avulsed wounds treated with the dry powder presented surfaces which, due to the large amount of tissue fluid, blood and serum, formed a rather definite coagulum. It was first thought that this coagulum might retard healing. However, no such difficulties were encountered. In many cases, the coagulum was gently removed with forceps and in others the coagulum was left undisturbed. There seemed to be little difference in the rapidity of healing in either case. Cytological studies on a series of wound coagula will be discussed below.

Foreign Bodies, Exploratory Wounds. In a series of twenty-six cases no infection was encountered following the removal of foreign bodies although in some instances there was gross contamination and considerable delay from time of injury to removal. A number of sulfonamide preparations was used in this series, all of them containing as one of the ingredients an oxidizing agent.

Fig. 1. Grossly contaminated and extensive avulsed laceration of ear in which primary repair with aid of potentiated sulfonamide was attempted.

Fig. 2. Postoperative result ten days later. Primary union accomplished with no inhibition of reparative process.

OPERATIVE WOUNDS

Under this title are included various intra-abdominal and skeletal lesions of graver import as well as a rather heterogeneous group of cases, among them lipomas, fibromas, sebaceous cysts, bursae, ganglia, etc.

In the past, among patients coming to our clinic for redressings following excision of more or less minor surgical entities, we have noted frequent occurrence of wound redness, "stitch" abscesses and even frank purulent infection. The incidence of postoperative sepsis in these minor cases exceeded the usual rate of postoperative contamination in major cases—herniorrhaphies, appendectomies, cholecystectomies, etc.

Much of minor surgery is performed at physicians' offices, out-patient departments and dispensaries. The fact that there should be no sepsis following minor surgical procedures does not obviate the persistent findings in these cases of a high

incidence of complicating wound infection. In these cases, regardless of previous treatment outside, we have adopted and have followed the use of sulfonamide powder and sulfonamide activated impregnated gauze. In our hands, this has markedly reduced the duration of complicating infections.

In a wide variety of clean operative wounds we have observed no retardation of healing with the sulfonamide medication.

The management of postoperative infections following various major surgical procedures is most effective when sulfonamide-oxidizing agent combinations are employed. Adequate drainage is provided by opening the incision as the individual case requires. Débridement of nonviable tissue is carefully carried out. The wound is thoroughly irrigated with hydrogen peroxide. One of the sulfonamide mixtures containing an oxidizing agent is placed in contact with all wound surfaces and then overlaid with medicated gauze squares of packing impregnated with the same mixture. The first dressing is not disturbed for from three to five days depending upon the extent of the infection. The procedure is repeated, progressively increasing the intervals between dressings to a maximum of five to six days. The prompt control of suppuration and the elaboration of healthy granulations is noticeable in many cases at the second dressing. The treatment of postoperative infections by this method has been uniformly good. A case in point is cited:

A fifty year old female had been operated upon for intracapsular fracture of the femur with insertion of a Smith-Petersen nail. The severe postoperative infection which developed had been treated for more than a week by drainage and the local applications of azochloramid in triacetin. In spite of treatment, suppuration continued and it was feared that the infection might finally involve the bone with loss of the nail and subsequent development of an osteomyelitis. Cultures showed Staphylococcus aureus hemolyticus. At this point the wound was carefully débrided and we instituted treatment with an activated sulfonamide mixture (sulfathiazole 10 Gr. to 100 cc. of azochloramid in triacetin). Up to this time dressings had been done daily without control of suppuration. The first redressing following the application of the sulfonamide medication was performed in four days. At that time suppuration had ceased and the beginning of repair by granulation was noted. Redressings were continued at intervals of five to six days and at the end of three weeks the wound was sufficiently healed to allow the patient to be out of bed and ready for discharge to convalescent care.

We suggest, in the face of what we are certain will be marked opposition, that all surgical wounds before closure be flushed with a warm solution containing 1 per cent sulfanilamide and .6 per cent sulfathiazole, with a 1:10,000 compound iodine mixture, and that on completion of closure the wound edges be covered by a strip of medicated gauze. This is particularly desirable for operations of long duration accompanied by unavoidable tissue trauma such as breast plastics or abdominoperineal resections. We are now studying a controlled group of cases which tend to prove that this addition to routine surgical procedure will definitely cut the incidence of sepsis. These observations will be incorporated in a later report.

HAND INFECTIONS

Our various sulfonamide mixtures were employed in the treatment of a large group of hand infections.

As a rule the powder mixtures were applied with a blower to a surface moistened with hydrogen peroxide after proper drainage of underlying infections had been established. Pastes combining these agents were also used. Where a drain or drain pack is indicated, a strip of the "Nu-gauze" impregnated with an oily suspension containing sulfanilamide and sulfathiazole in either hydrogenated cocoanut oil or triacetin, and activated with minute amounts of compound solution of iodine, azochloramid, benzoyl peroxide or zinc peroxide is suggested. In any case, the dressing is fol-

lowed by delayed soaks, the medication being allowed to remain *in situ*.

This use of "delayed soaks" is a general principle which we offer for acceptance. To be fully effective, the local application of the sulfonamides or sulfonamide-oxidizing mixtures to all wounds associated with inflammation and cellulitis should be exposed to the beneficial effects of moisture and heat. By allowing four to six hours to elapse, the involved tissues have had an opportunity to absorb directly a certain amount of the chemotherapeutic agents and by this time moisture and heat will not only be of nonspecific help but will aid the further local absorption of the excess of the sulfonamide mixture.

We have found it practical to leave a sulfonamide dressing undisturbed for from four to five days and thereafter to dress it at intervals of five to seven days, cleaning the wound thoroughly with hydrogen peroxide, replacing the paste or powder and following this by immobilization. The need for frequent dressing is eliminated by this method, and, as Iselin[37] pointed out, too frequent dressings are one of the chief causes of chronicity in this type of lesion.

Anterior closed space infections were treated with the "fish mouth" or "hockey stick" incision. This group was found to fare better when dressed with pads and strips of moistened impregnated gauze (oily) than with dry powder. It became obvious that in small areas of infection where possible drainage obstruction was present, the dry powders are contraindicated unless accompanied by intermittent soaking.

Flexor sheath infections required more frequent dressing than the other types, although daily dressings are not indicated. In this group we have to deal more often with the problem of necrotic tissues which offer an abundance of peptone and peptone-like bodies which have been shown inhibitory to sulfonamide action.

Osteomyelitis of the Terminal Phalanx. We prefer Kanavel's[38] active technic in contrast to Knapp's[39] "wait and see" method. The distal two-thirds of the phalanx is resected after the periosteum has been pushed down to the lower third. The wound is then filled with a thin paste containing the sulfonamide and oxidizing agent before removal of the tourniquet and is not disturbed for six to seven days unless temperature and pain warrant an earlier inspection. As a rule, pain and temperature will subside within forty-eight hours.

We have operated upon fifteen patients with osteomyelitis of the terminal phalanx in which the primary incision or, as we have found in many cases, incisions, were made by others. In none of these cases, had any type of sulfonamide mixture been used previous to the secondary operation. In contrast, no complicating osteomyelitis of the terminal phalanx or other extension of infection has occurred in the group which we treated early with sulfonamide-oxidizing agent mixtures. The oft tendered criticism that simple incisions might have produced similar results may be a just one. It is true that many paronychias, eponychias, subepithelial and subungual abscesses could be cured quite simply by the proper incision and drainage. We are of the impression, however, that the use of sulfonamides plus oxidizing agents locally, followed by "delayed" hot soaks, have a definite place in the treatment of all hand infections. While progression of the simpler types to more grave forms may not be common, any treatment which may hasten the end of the infection should be considered worth while.

HUMAN BITE INFECTIONS (MORSUS HUMANUS)

We doubt if any single type of wound requires more diligence and more exacting treatment than those of this group. Koch,[40] barely ten years ago, presented the first insight into this problem as a surgical entity and clearly demonstrated the anatomical considerations. In two recent reports, the results were far from favorable: Welch[41] reported six amputations and five

secondary operations out of his series of eighteen cases. He believes that a 33 per cent morbidity (flail or stiff joint) may be anticipated. The other series, reported by Boland,[42] records a similarly high incidence of amputations as well as several deaths. R. L. Maier[57] reported seventeen cases. He pointed out the importance of exploration of lesions over the knuckle in the flexed position. His results using salvarsan locally were excellent in early cases. There were four amputations in the late cases. More recently, he has used sulfanilamide locally but believes proper débridement to be of paramount importance. In this we concur.

It is important not only for the patient to seek immediate attention following this type of injury, but it is just as important for the physician accepting the responsibility to realize the septic nature of the injury with which he is dealing and the need for prompt attention. Regardless of the appearance of the wound itself, when the patient presents the history of having received it through the agency of human teeth, it becomes necessary to excise the adjacent tissues for at least one-eighth of an inch beyond the wound's border. The débridement, if the wound is situated in the region of the metacarpal head, is best done with the closed hand. This is the position in which the injury is, as a rule, sustained. Thus if the extensor tendon has been involved, it would, in the extended position, slide out of view.

It is advisable to flush out the wound with hydrogen peroxide and pack it with a mixture of sulfanilamide and sulfathiazole powders activated with either iodine compound solution in triacetin, 1:5,000, azochloramid in triacetin, 1:500, or zinc peroxide powder. The latter seems most effective.

We have treated eleven patients in this series. The earliest was seen fifteen minutes after the injury and the latest not until six days had elapsed. We believe that regardless of the intervening time and the nature of the wound presented, treatment is basically the same. It frequently becomes necessary to sacrifice areas about the metacarpal-phalangeal joint as well as tendon. In our present experience, this group of human bite infections has not necessitated a single amputation. We may cite a case in point which has several interesting side-lights:

A white male, aged forty-four, struck his opponent in the mouth, sustaining a jagged laceration over the middle metacarpal phalangeal joint on the dorsal surface. It was six days before he sought medical aid. It is of passing interest to note the reason for this delay; it was due to a newspaper announcement that the police were searching for a man with this type of wound in connection with the murder of a woman. Not until the real culprit was apprehended did this patient present himself for treatment, six days after the injury.

The wound, one inch in length, extended obliquely over the joint. It exuded a profuse foul smelling discharge. The middle extensor tendon was apparently involved; the entire dorsum of the hand and middle finger showed marked swelling and dusky redness.

An elliptical excision of all tissue with extension for drainage up the dorsum of the hand was made. The extensor tendon itself was débrided only in part but was finally excised completely when found impossible to salvage.

Treatment consisted in flushing the wound thoroughly with hydrogen peroxide and packing it with a powder composed of equal parts of sulfanilamide and sulfathiazole with one-fourth part of zinc peroxide to supply the desirable oxidation environment. The wound was then overlaid with a medicated dressing containing sulfanilamide-sulfathiazole-azochloramid paste. At the beginning of the treatment lymphangitis, axillary adenitis and general constitutional symptoms were present. Improvement was continuous; the surrounding inflammatory reaction subsided, axillary gland involvement disappeared and suppuration was under control after six days. This therapy was continued until epithelialization on the granulating base was noted. Photographs were taken at the time of the excision and again with the final result. (Figs. 3, 4 and 5.) At the end of treatment there was only a limited (10 degree) impairment of full extension of the middle digit.

In five human bite infections seen within six hours, the method selected consisted of excision of the wound and packing with one of the above fortified sulfonamides followed by delayed intermittent saline soaks. In these no suppuration occurred. This group of wounds progressed to granulation and epithelialization without complication. In one case first seen eighteen hours after injury the wound edges were agglutinated, releasing foul smelling thin pus on separation. This wound was over the fifth metacarpal-phalangeal joint. Débridement included part of the capsule of the joint and an incision to evacuate the dorsal space. Recovery in this instance was completely satisfactory except for a slight defect in motion of the fifth finger.

Cultures and smears were made from these lesions. Blood broth agar yielded, for the most part, Staphylococcus aureus as a secondary organism to the streptococcus and Vincent's organisms noted on smears. The same technic was followed in the group seen late, but adequate drainage was provided. There were no deaths and no amputations. We shall report upon this subject more fully at a later date.

It should be further stated that in our group we withheld sulfanilamide therapy by mouth, thus giving us a rather definite means of determining the effectiveness locally of these compounds. However, it is advisable to use oral sulfonamides in cases of this type as an adjutant.

Radical, immediate treatment is indicated for wounds caused by the human bite. In every case the wound edges should be excised for at least a distance of one-eighth of an inch. The wound then is to be thoroughly flushed with hydrogen peroxide, followed by the local application of the activated sulfonamide mixture. In additional cases of this type of lesion, we have used several of many activating agents (oxidizing agents) such as potassium permanganate, iodine, zinc peroxide, azochloramid, etc. Our preference in this group is for the zinc peroxide-sulfonamide compound. The preparation should be placed generously in contact with all surfaces and depths of the wound. As already stated, it is advisable to delay any soak for six hours to allow local concentration of the sulfonamides in the tissues. Soaks may then be intermittently instituted every four hours, using normal saline.

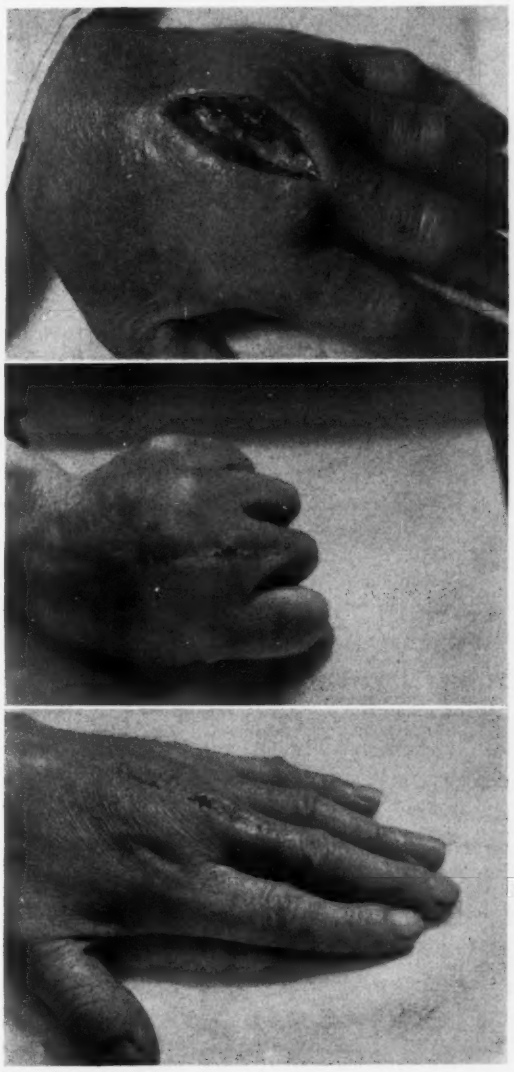

Fig. 3. Human bite infection as it appeared following preliminary excision and topical application of the No. 15 sulfonamide mixture.

Fig. 4. Human bite infection (Figure 3); end result showing unlimited flexion.

Fig. 5. Human bite infection (Figure 3); end result showing almost complete extension.

We offer as contrasting controls for this group the reports of Welch[41] and Boland.[42] We believe the value of the potentiated sulfonamides has been clearly demonstrated when on several occasions in which

nonactivated sulfonamide was used, regression of healing occurred and we were forced to return to the activated form.

ABSCESS CAVITIES

A number of abscess cavities came under treatment, some without local medication, others with the usual run of antiseptics and still others with the sulfonamides, both activated with an oxidant and nonactivated. There can be little doubt about the increased efficacy *in vivo* of the activated sulfonamides in this group. Powders and pastes were used, also impregnated oily pack drains. The choice was largely on an anatomical basis, depending upon the size, configuration and position of the abscess cavity. The repeated observation of prompt cessation of suppuration, diminution of swelling and subsidence of surrounding inflammation with rapid granulation and healing was in itself so marked as to leave little doubt as to the superiority of this means of therapy.

The various types of abscesses need little discussion. The use of a sulfonamide intraperitoneally in the treatment of abscess or peritonitis of appendiceal origin has been reported by Mueller,[24] Ravdin et al.[43] and others. The placing of sulfonamide crystals or powder, previously heat sterilized, in the peritoneal cavity has become a more or less common practice in this type of case. In a few instances we have used 5 Gr. of sulfathiazole, activated with 0.2 Gr. of buffered azochloramid powder in abscesses of appendiceal origin. The abdominal layers were thoroughly flushed with a solution of the same mixture and closed with drainage. At present, for intraperitoneal application we advise the use of sulfanilamide and sulfathiazole powder or crystals in a 2:1 proportion. In general the potentiating agents thus far at our disposal are not recommended for intraperitoneal use. Further work in this field is being done.

In the ubiquitous suppurative sebaceous cyst in which dissection of the entire sac is impossible, we have repeatedly observed prompt subsidence of suppuration. The significant findings in these lesions were lack of induration and freedom from chronicity. Healing has been about as prompt as in the simple subcutaneous abscess. Recurrence and recrudescence of infection have been minimized by the effective sterilizing action on any remaining fragments of the sac wall. As a rule, the cavity has been filled with either a sulfonamide paste or powder. A small impregnated gauze wick, which is removed at the end of twenty-four hours, provides additional medication and drainage in the early stage of treatment.

CARBUNCLES

We have employed but two surgical procedures in this group. The undermined cruciate incision has been used in the less extensive and smaller lesions; excision has been reserved for the more extensive and late cases. More effective and prompt control of the surrounding inflammatory zone has been observed with the fortified sulfonamides than with any other type of medication. Again, the choice of powder, paste or impregnated gauze depended upon the characteristics of the individual lesion. Impregnated gauze covered with impervious dressings has a definite place in the larger lesions. Complete filling with the powder was accomplished by means of an insufflator. Absorption of the sulfonamide was demonstrated by serum determinations. This was found to be more rapid and sustained in the powder groups. Caution is, therefore, suggested if a sulfonamide is also administered orally at the same time.

BURNS

We are concerned here only with the local therapy and assume of course that the treatment of shock, fluid loss and protein concentration have received ample attention whenever required. The total area of a burn is an important consideration in treatment. That the sulfonamides locally applied to burned areas are readily absorbed into the circulation has been

demonstrated by blood level determinations. In one of our cases, cyanosis, anorexia and nausea were attributed to the absorbed sulfonamides; Hooker and Lam[44] have mentioned toxic phenomena in two cases in which large amounts of the sulfonamides were used. We have employed powdered sulfanilamide or sulfonamide mixtures plus oxidizing agents as well as gauze squares impregnated with these medications. We have also applied by spray an emulsion containing 2 per cent sulfanilamide and 1 per cent sulfathiazole combined with 0.5 per cent zinc peroxide, using gentian violet-acriflavine solution as a vehicle. In the smaller burns the sulfonamide-zinc peroxide powder was dusted over the area, producing an eschar-like surface. These were covered with a parawax mesh dressing. Larger burns were sprayed with an atomizer, using the emulsion mentioned above, or covered with a water-soluble jelly containing the same ingredients. Pickrell[45] has recently reported the use of a 3 per cent sulfadiazine mixture in triethanolamine. Feinstone et al.[46] have recently summarized their experimental and clinical experience with sulfadiazine. Evaluation of its effectiveness locally requires further study. Our impression thus far indicates its superiority in oral therapy only. We did not encounter a secondary infection in any burn cases treated with the oxygen-potentiated sulfonamide mixtures.

Our series of burns, however, is small and further investigation is necessary. It is safe to state, nevertheless, that caution as to total dosage should be observed and that the potentiated sulfonamides offer, in this type of infection, as well as in the other lesions mentioned, a rather promising form of treatment. No more than 8 Gr. should be used in any twenty-four hour period, proportionately less for children. Cumulative absorptions should be borne in mind until the eschar-like crusts have become more firm.

Studies on various types of impregnated sulfonamide gauzes are being followed, as we believe this to be the best type of secondary dressings in burn cases, as well as the most satisfactory emergency dressing in which local sufonamides are to be continued as the eventual treatment. The gentian violet and activated sulfonamide jelly offers an easily applied primary dressing.

LEG ULCERS

The subject of leg ulcer is familiar to any surgeon who has attended surgical clinics for any length of time. It is quite beyond the scope of this paper to delve into the many problems associated with this lesion. We do not mean to disregard the various factors which at all times should be given axiomatic consideration, such as the state of the peripheral vascular system, constitutional disease, syphilis, diabetes, anemia, etc. For the purpose of this study we are concerned primarily with the problem of infection and assume that the other necessary treatments have received proper attention. In spite of all these general and local measures we have seen every conceivable type of mixture applied topically and have at some time or other in the past used most if not all of them ourselves. Our culture study from this group of wounds has indicated that Staphylococcus aureus and albus are the most predominant organisms but in many cases cultures have shown both streptococcus and staphylococcus.

We are forcibly struck with the persistent efficacy of the sulfonamides when applied to these wounds. In our first study, we powdered the wound surface with sulfanilamide crystals. We later combined sulfanilamide with sulfathiazole in equal parts; but the most effective means of therapy again was found to be a fortified mixture containing sulfathiazole and sulfanilamide with an oxidizing agent, for example, compound iodine solution 1:5,000 in triacetin or azochloramid in olive oil, 1:2,000; or zinc peroxide, 1:2,000 in sesame oil, cod liver oil or cocoanut oil. With this latter group we were able to control

quickly the superficial suppuration and were quite impressed with the repeated production of a clean, healthy, red granulating base which in many cases allowed the epithelial edges to close in rapidly.

We do not mean to infer that every leg ulcer can be completely healed by the simple application of one of these mixtures. Only too often we have brought the lesions to a standstill beyond which further progress was not evident. To complete healing it has sometimes been necessary to employ medicated boots, elastikon strappings, and in some instances vein injections, ligations and pinch grafts.

Nevertheless, many leg ulcers have been healed which had been previously treated by other means for periods ranging from six months to four years. Here, too, the effectiveness of local medication was increased by the simultaneous use of a sulfonamide compound and an agent of oxidizing properties.

The cellulitis and edema associated with infected ulcers first invited a choice between the use of elevation and hot wet massive dressings or soaks, and the use of the local sulfonamides. An extremely satisfactory and effective method was found in the following routine:

1. Adequate drainage of pockets when necessary.
2. Gentle débridement of wound.
3. Removal with ether of any oil or grease-containing medication previously applied.
4. Application of an activated sulfanilamide mixture directly to all parts of the wound by free swabbing or by insufflation.
5. Covering of the wound with gauze impregnated with sulfanilamide mixture.
6. Application of impervious perforated squares of cellophane or cilkaloid over the medicated dressing.
7. Bulky dressings for ample covering of wound and surrounding area.
8. Rest and dry heat to the part for six to eight hours, followed by:
9. Intermittent hot wet applications of normal saline every three to four hours.
10. Dressing changes at forty-eight to seventy-two-hour intervals.
11. This process is repeated, gradually lengthening the intervals between dressings and the number of wet applications as indicated by the progress of the wound.
12. When cellulitis and edema have subsided and the wound surface shows a healthy granulating base, pinch graft or a Thiersch graft may be attempted if the size of the lesion warrants it.

Small ulcerations may be dressed at weekly intervals with sulfonamide mixtures, preferably in the form of paste or ointment. By this method the beneficial effects of moisture and heat are maintained and the fortified sulfonamide is allowed to reach a beginning rise in the absorption curve so that local tissues have some degree of sulfonamide saturation before wet dressings are begun. The moistening of the dressings with normal saline further facilitates the local absorption of the sulfonamide at the time and prevents caking or crusting. Residual sulfonamide powders might be seen on many wounds after intermittent soaks without a change of dressing.

MISCELLANEOUS SURGICAL INFECTIONS

The sulfonamide-oxidizing agent mixtures have been utilized in the treatment of a heterogeneous group of cases covering many other types of lesions. Although no statistics are available, our findings have indicated this to be the most effective means of local therapy at our disposal at present.

It was found practical to apply the same principles to other fields of surgery. Thus in *gynecologic* lesions we obtained successful results in the treatment of vaginal and cervical infections, both of bacterial and trichomonas origin. Three modes of medication were found to be successful. Insufflation of a powder containing sulfanilamide and sulfathiazole plus zinc peroxide, use of impregnated cotton vaginal tampons, and vaginal suppositories containing sulfanilamide, sulfathiazole and zinc peroxide in a cocoa-butter base were

each found to be more effective than other methods used previously.

Excellent results were obtained in eleven cases of marked vaginal discharge with associated severe pruritus. In six of these the presence of the trichomonas was readily confirmed by examination of the saline smear. A routine was established for this type of case. All douches were prohibited. The vaginal canal and vulvar area were carefully cleansed with hydrogen peroxide, then thoroughly insufflated with the powder. Vulvar skin was then covered with an application of 2 per cent fuschsin or gentian violet-acriflavine solution and again insufflated with the powder while the dye was drying. Involved skin areas were then painted with collodion, which were allowed to dry. This was repeated twice weekly and in the interval the patients' instructions included the insertion of a sulfonamide-zinc peroxide suppository nightly or every other night before retiring. The results were exceptionally satisfactory, and particularly gratifying to the patients who had previously had little, if any, relief from itching and discharge. The prompt and consistent disappearance of the trichomonas in these cases was particularly noteworthy.

The same technic, omitting the skin treatment, has been found very effective in the postoperative management of cervical conizations, cauterizations and vaginal plastic procedures.

A colleague in the field of *otolaryngology* has reported encouraging results in otitis media with the potentiated powder mixture.

Although the successful use of sulfanilamide has been reported in the treatment of compound fractures by many observers, we believe that their results can be further enhanced by utilization of these newer combinations.

Similarly, in *orthopedic* and *traumatic surgery* with particular reference to war wounds, the satisfactory results obtained by the use of the Orr-Trueta technic as applied to bony and soft tissue injuries may be considerably increased by substituting gauze packing impregnated with a potentiated sulfonamide for the ordinary vaseline gauze.

For similar reasons we advocate the use of enemas of sulfanilamide and sulfathiazole with potassium permanganate in the treatment of suppurative, ulcerative and otherwise infectious lesions of the colon and rectum.

A variety of cutaneous infections were treated with the sulfonamide preparations. They were particularly efficacious in several instances of extensive pyodermia. Impetigo and furunculosis responded favorably to dusting with the zinc peroxide activated powder supplemented by the ointment form. Several cases of resistant fungus infection (epidermophytosis interdigitale) were promptly controlled by a powder consisting of sulfanilamide, sulfathiazole and benzoyl peroxide. It is very likely that the activation of the fungicidal properties of the sulfonamides is further aided by the reduction product, benzoic acid, which exhibits a desquamating effect.

IDIOSYNCRASY

In the many thousands of dressings in which the sulfonamides were used, we encountered but three definite instances of idiosyncracy to the drugs. One was the case of a male, twenty-six years of age, who had suffered an avulsed wound of the anterior portion of his leg. Shortly after the first application of sulfanilamide powder, an angry, red raised area developed about the wound and spread to the surrounding tissues accompanied by a diffuse papular rash. Under wet dressings with boric acid solution this subsided. Repetition of the application of the sulfanilamide caused a recrudescence of the local irritation and a recurrence of the rash.

Another case was that of a man, fifty-six years of age, with leg ulcers of long standing and an old thrombophlebitis on the same leg.

The third instance was the most bizarre and probably exemplifies an acquired sensitivity. It occurred in a fifty-two year old male who had been treated for an acute suppurative olecranon bursitis. After three

weeks of treatment the patient was well enough to be discharged. Two weeks later, however, there was an apparent recurrence and the same sulfonamide preparation was used. In twenty-four hours there was a widespread moist eczema about the involved elbow, surrounded by diffuse papular lesions. The sulfonamide was again used locally and within the following twenty-four hours a generalized papulopustular rash developed over the entire body. This was accompanied by severe weakness, anorexia, nausea and temperature. The white cell count was 20,800 and the urine showed 3.0 per cent sugar. Saline baths were instituted and, as all contact with the sulfonamides was removed, improvement immediately followed. Three days later, the constitutional symptoms were absent, the rash was subsiding and the urinary sugar was negative. (Figs. 6 and 7.)

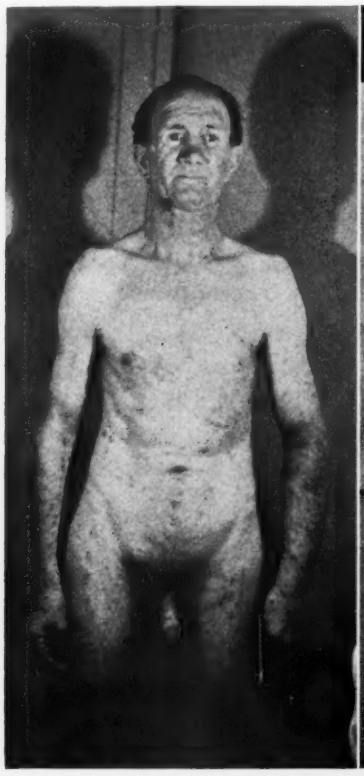

Fig. 6. Idiosyncrasy to topical application of sulfonamides for left suppurative olecranon bursitis. Note edema and discoloration about lesion and forearm with disseminated papulopustular eruption over face, trunk and extremities.

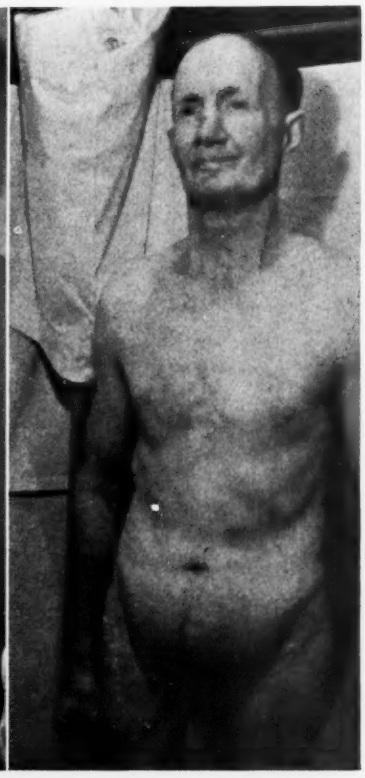

Fig. 7. Eight days following removal of all contact with sulfonamide. Edema and discoloration have subsided and the eruption is fading. Note also general improvement in appearance.

We believe that, except in rare instances, no irritation is produced by the local application of the sulfonamides.

LABORATORY DATA

Wound Flora. A series of 100 consecutive, unselected wounds was studied. The following table indicates the incidence of organisms encountered:

Table III

	Per Cent
Staphylococcus pyogenes aureus	48
Staphylococcus pyogenes albus	32
Streptococci	9
Diplococci	6
Bacillus coli	3
Bacillus pyogenes	2

No attempt at a differential classification of these organisms was made. This table has little significance except that it indicates a general cross-section of the types of infection encountered in this study. It does stress, however, the importance of the staphylococcus as a predominant organism. While sulfanilamide serves as a more or less effective barrier against the ever present potential flare-up of streptococcic origin, we are here reminded of the desirable antistaphylococcic properties of sulfathiazole and the reason for using the combined sulfonamides. It is our confirmed impression that the mixture is much superior to either sulfonamide alone in local therapy.

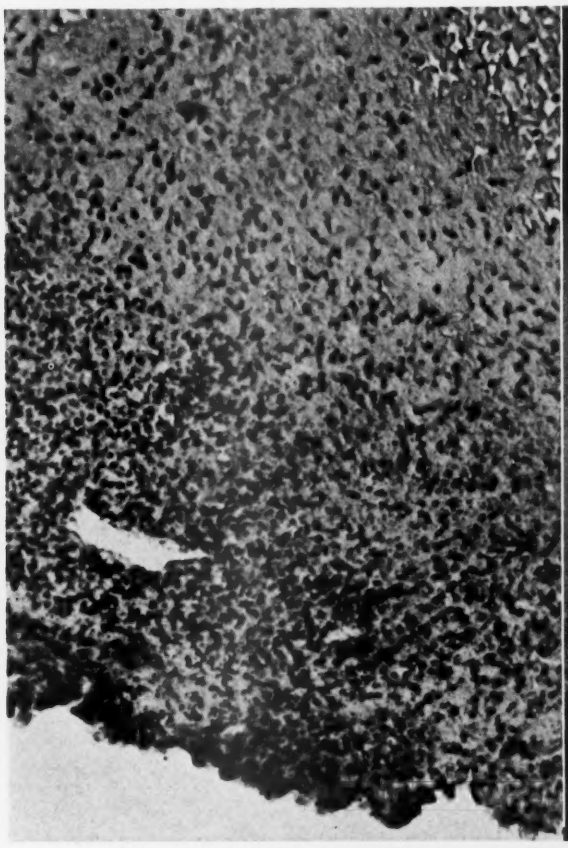

Fig. 8. Photomicrograph of coagulum removed from sulfonamide treated wound surface. The bottom of the photograph represents that part in direct contact with the wound surface. Note the highly cellular nature of this section made up of many fibrocytes, lymphocytes and occasional giant cell. The cellular invasion extends well up into the sulfonamide mass. In the right hand corner are spaces in which sulfonamide crystals were present. Studies of many sections of this type indicate that the sulfonamides offer no real inhibition to wound healing.

Fig. 9. Appearance of wound coagulum from which section (Fig. 8) was made. Lesion was a suppurating ulcer on middle third of leg associated with an acute extensive cellulitis.

STUDY OF SURFACE COAGULUM

We early noted the frequent appearance of a coagulum on the surface of wounds treated with the various types of sulfonamide preparations. This interested us considerably because of its possible bearing upon sulfonamide absorption and upon wound healing.

The type of coagulum varied from the dry crust seen on abrasions to an adherent pseudomembrane which covered the deeper

lymph-rich wounds from edge to edge. The coagula were removed and placed in formalin for later inspection. Cytological and bacteriological studies were made to determine, if possible, the presence of foreign body reaction, bactericidal, phagocytic or other characteristics. A photomicrograph of a typical sulfonamide wound coagulum is seen in Figure 8. Photograph of wound from which this coagulum was removed is illustrated by Figure 9. We found evidence of slight foreign body reaction and occasional giant cell formation. Sections stained for bacteria indicated some degree of phagocytosis and a definite diminution in the number of bacteria as compared with coagula or membranes removed from wounds treated with some more or less inert paste, such as boric acid ointment, which in some cases may leave a similar coagulum.

EFFECT OF SULFONAMIDE-OXIDANTS UPON STAPHYLOCOCCUS AUREUS IN VITRO

The inhibitory effects of sulfanilamide and sulfathiazole, singly and in combination, are tabulated below. Also are included the effects of two nonoxidizing antiseptics (merthiolate and mercurochrome) alone and in combination with the sulfonamides compared with a similar series involving two oxidizing antiseptics (azochloramid and Lugol's iodine solution).

COMPARISON OF EFFECTIVENESS OF SULFONAMIDES, ACTIVATING AND NONACTIVATING AGENTS AGAINST STAPHYLOCOCCUS AUREUS

Broth Media .1 cc. inoculum (24-hour culture)	Clouding 24 hrs.	48 hrs.	72 hrs.
(A) Sulfanilamide 1:10,000	−+	++	++
(B) Sulfathiazole 1:10,000	−+	++	++
(C) Sulfanilamide plus sulfathiazole, 1:10,000	−−	−+	++
Merthiolate 1:50,000	++	++	++
Merthiolate plus sulfonamide A	++	−+	++
Merthiolate plus sulfonamide B	+−	−+	++
Merthiolate plus sulfonamide C	−−	++	++
Mercurochrome 1:50,000	++	++	++
Mercurochrome plus sulfonamide A	+−	++	++
Mercurochrome plus sulfonamide B	−+	++	++
Mercurochrome plus sulfonamide C	−+	−+	++
Lugol's solution 1:50,000	++	++	++
Lugol's solution plus sulfonamide A	−−	−+	−+
Lugol's solution plus sulfonamide B	−−	−−	+−
Lugol's solution plus sulfonamide C	−−	−−	−−
Azochloramid 1:50,000	++	++	++
Azochloramid plus sulfonamide A	−−	−−	++
Azochloramid plus sulfonamide B	−−	−−	−+
Azochloramid plus sulfonamide C	−−	−−	−−

EFFECT OF ACTIVATED SULFONAMIDES ON OTHER UNICELLULAR ORGANISMS

The effects of the sulfonamides on ameba, paramecia, trichomonas and spermatozoa were observed. Here again it is possible to show that two more or less ineffective dilutions (sulfonamides and oxidizing agents) form together a very effective antibiotic agent. The arrest of the motility of these larger single celled organisms is a striking demonstration of the principle which we have applied in surgical practice.

The significance of this observation should not be overlooked or passed on lightly merely as an interesting observation. It gives much credence to our theory of mode of action, and in our opinion tends to place the phagocytic factor, so strongly suggested and developed by the many excellent experiments of Long and Bliss[47] and others, in a secondary position. These same investigators had earlier concluded that sulfanilamide must act on the micro-organisms and not on the leukocytes; later they reinterpreted their observation.

SULFONAMIDE PREPARATIONS EMPLOYED

While more than 100 preparations have been used in the treatment of patients during this study, it is considered quite impractical and unnecessary to list them all. Included below are the formulas of various preparations which gave excellent results in the types of wounds indicating their use. (By referring to the table of wounds treated, the most suitable preparation for each category may be determined.)

It will be noted that most of the preparations contain, in addition to their sulfonamide content, an oxidizing agent. Because some of these combinations may

not possess prolonged stability, the oxidizing component is preferably added just prior to use.

Dried Crystals and Powder. In this group the sulfanilamide crystals were used directly on infected wound surfaces and in cavities, with a powder blower. The sterile gauze pad applied directly to the wound was also given a coating of powder to reinforce the insufflated material.

No. 15.
- Sulfanilamide ..... 4 parts
- Sulfathiazole ..... 2 parts
- Zinc peroxide ..... 1 to 2 parts

No. 16.
- Sulfanilamide ..... 2 parts
- Sulfathiazole ..... 2 parts
- Iodoform ..... 3/10 part

No. 17.
- Sulfanilamide ..... 2 parts
- Sulfathiazole ..... 2 parts
- Benzoyl peroxide ..... 1 part

Solutions and Suspensions. It is apparent that true solutions are of comparatively limited value due to the relative insolubility of the sulfonamides. The 1 per cent solution of sulfanilamide was soon discarded in the treatment of infected wounds but it was reserved for prophylactic wound irrigation.

Because aqueous solutions are limited to high and ineffective dilutions, they were replaced by liquid suspensions in higher concentration. Early, suspensions of sulfonamides—sulfanilamide, sulfathiazole and sulfadiazine—were used separately. Later, sulfanilamide and sulfathiazole were used together (for example, No. 26 solution).

No. 2.
- Sulfanilamide and/or sulfathiazole .... 10 Gm.
- Azochloramid in triacetin ..... 1:500 100 cc.

No. 99.
- Sulfanilamide ..... 10 Gm.
- Sulfathiazole ..... 6 Gm.
- Potassium permanganate, 1:4000 ..... 1000 cc.

No. 26.
- Sulfanilamide ..... 0.8 Gm.
- Sulfathiazole ..... 0.6 Gm.
- Lugol's iodine solution ..... 2.0 cc.
- Distilled water ..... q.s. 100 cc.

No. 43.
- Sulfanilamide ..... 20 Gm.
- Sulfathiazole ..... 10 Gm.
- Sodium tetra-decyl sulfate ..... 2 Gm.
- Azochloramid in triacetin (1:500) .... 100 cc.

No. 83.
- Sulfanilamide ..... 25 Gm.
- Sulfathiazole ..... 12.5 Gm.
- Iodine stock solution (I_2 = 2.2 gr. per cc.) (1 to 5,000) ..... 1 cc.
- Glyceryl triacetate ..... 250 cc.

Ointments and Pastes. In this group high concentrations of the sulfonamides are possible. Many experimental ointment bases were tried. These included petrolatum, lanolin, aquaphor, spermaceti, cocoa-butter and vanishing cream in various combinations.

No. 40.
- Sulfanilamide ..... 10 Gm.
- Sulfathiazole ..... 5 Gm.
- Zinc peroxide ..... 2.5 Gm.
- Lanolin, or one of several water soluble bases q.s. ..... 100 Gm.

No. 48.
- Sulfanilamide ..... 5 Gm.
- Sulfathiazole ..... 5 Gm.
- Azochloramid in triacetin 1:500 ..... 10 Gm.
- Balsam of Peru ..... 20 Gm.
- Lanolin q.s. ..... 100 Gm.

No. 81.
- Sulfanilamide ..... 50 Gm.
- Azochloramid in triacetin ..... 60 cc.

No. 89.
- Sulfanilamide ..... 4 Gm.
- Sulfathiazole ..... 2 Gm.
- Zinc peroxide ..... 1 Gm.
- Gentian violet ..... 1 Gm.
- Acriflavine ..... 0.1 Gm.
- Water-soluble base (with wetting agent) q.s. 100 cc.

No. 90.
- Sulfanilamide ..... 4 Gm.
- Sulfathiazole ..... 4 Gm.
- Lugol's iodine ..... 5 cc.
- Na tetradecyl sulfate ..... 2 cc.
- Oil of lavendar ..... 5 drops
- Glycerol triacetate ..... 10 cc.
- Balsam of Peru ..... 10 Gm.
- Lanolin q.s. ..... 100 Gm.

Suppository.

No. 60.
- Sulfanilamide ..... 1 Gm.
- Sulfathiazole ..... 1 Gm.
- Zinc peroxide (special) ..... ½ Gm.
- Na tetradecyl sulfate ..... 0.2 cc.
- Cocoa butter q.s. ..... 4 Gm.

Impregnated Gauze. Gauze preparations containing various concentrations of the formulas suggested have been found useful in the packing of infected cavities and for the dressing of infected wounds. Such impregnated gauzes are of practical importance, particularly in hospitals, dispen-

saries and out-patient departments as well as in industrial clinics in which a great number of dressings are to be done. Such gauze may be kept ready for use in suitable containers. In this way minimum time is required for the dressing. This subject is being investigated for fuller discussion at a later date.

MECHANISM OF SULFONAMIDE MEDICATION

Long has stated, "When we come to the consideration of how sulfanilamide and its derivatives bring about the inhibition of growth, we enter the realm of pure fancy." However, on the basis of the theory that bacteria, both anaerobes and aerobes, produced hydrogen peroxide in the presence of oxygen, and that if this hydrogen peroxide were, through the means of chemotherapy, allowed to accumulate, a condition of bacteriostasis would inevitably result. Various factors indicate that the sulfonamide drugs may operate in this fashion. Hydrogen peroxide is known to be highly depressant to bacterial metabolism. However, under normal *in vivo* conditions the catalase in the tissues, as well as that existing in some bacterial cells, prevents the accumulation of hydrogen peroxide by destroying it as fast as it is evolved. If we may assume that the sulfonamides act in limiting the effectiveness of catalase and thus promote the accumulation of bacteriostatic levels of hydrogen peroxide, we may also assume that the addition of oxygen to the system through the medium of an oxidizing agent promotes and augments the production rapidly by the bacterial cells of a product inimical to their own existence. Under these circumstances, hydrogen peroxide comes into its own as a very effective antiseptic agent. Many observers have recorded the existence of a lag period prior to the appearance of any bacteriostatic effect, even after the establishment of satisfactory sulfonamide blood levels. This tends to support the theory; the time lag may represent the period during which an effective level of hydrogen peroxide builds up. While it is highly probable that other enzyme systems are also affected adversely, we submit catalase as a type example.

Some have advanced their belief that phagocytosis plays the primary rôle in sulfonamide therapy. We believe, however, that this element is of secondary importance, disposing of the bacterial cells in the usual manner after hydrogen peroxide has reduced their viability.

Levaditi[48] stated that sulfanilamide prevents the specialized metabolic activity required of invading organisms. "The evidence so far obtained indicates that this effect may be achieved through the prevention of the utilization of the protein substrate by the organisms." He, however, stated that he could not as yet accept it as fact that the chemotherapeutic compounds acted directly upon the micro-organisms, the reason being that he found that if the drug were injected directly into the peritoneum, where it should come into immediate contact with infectious agents, the therapeutic response was far less than when administration was by the subcutaneous or oral route. It, therefore, seemed to him that the drugs, sulfanilamide as well as the dye derivatives, must undergo a further change in the body to a substance which he termed the "active principle X" (quoted from Long and Bliss[49]). Since that was written (1937), the use of sulfanilamide in the human peritoneal cavity has been proved very effective.

Lockwood[50] advances a theory which is quite similar to Levaditi's in that he considers interference with the bacterial source of nitrogen to be part of sulfonamide activity.

Locke and Main, Shinn and Mellon[51–54] have advanced fascinating principles which attempt to explain the mode of action as follows: "The pneumococcus and the hemolytic streptococcus have the property of being able to produce hydrogen peroxide without, at the same time, being able to prevent peroxide accumulation." Both are sensitive to peroxide injury and depend for peroxide elimination on catalase, borrowed

from the medium supporting growth. Catalases decompose peroxide and permit growth as long as they remain efficient. These enzymes are activated by substances related to hydroxylamine in structural properties. They then write that "substances analagous to hydroxylamine are produced from sulfanilamide when dilute solutions of the drugs are exposed to ultra-violet radiation and they should be easily produced from sulfanilamide by peroxide-producing pneumo and streptococci through equivalent processes of oxidative disintegration producing an amount of anti-catalase within the multiplying organisms sufficient to permit the accumulation of the hydrogen peroxide to levels forcing changes in gross character."

The effects of sulfanilamide in the treatment of experimental streptococcic infections of mice led Long and Bliss[55] to believe that the action was primarily one of slowing down the rate of multiplication and thus permitting the phagocytes to dispose of the bacterial cells. Other investigators have divergent opinions in regard to this. Shaffer[56] believes that the oxidized derivatives of sulfanilamide have a high oxidizing intensity which damages the reducing system of the bacterial cells as well as human cells, but that the human organism is better able to withstand these various effects than are the bacteria.

Lockwood[50] in discussing the mechanism of action concludes that sulfanilamide induces a physicochemical alteration in the antigenic structure of hemolytic streptococci which decreases its invasive capacity or virulence, and that the bacteriostatic effect thus produced is probably the results of a specific interference with enzymatic utilization by the bacteria of some nutritive chemical factor such as para-aminobenzoic acid. As a corollary to our theory above, available evidence suggests the possibility of an additional avenue of attack. It is well known that paraminobenzoic acid in small amounts will inhibit the action of comparatively large amounts of sulfonamide. If the simultaneous contacting with an oxidant facilitates oxidation of the paraminobenzoic acid—or the paraminobenzoic acid-like substances, it further enhances the sulfonamide action. Thus a two-fold purpose is theoretically served by the oxidant potentiated sulfonamide.

In going over the contributions of many investigators who have dealt with the subject of mechanism of action of the sulfonamides, we find that there are roughly two schools of thought, those who believe that phagocytosis plays an important or primary rôle and those who believe that the sulfonamide action is concerned more directly with the bacterial cell, and that phagocytosis is merely an expected sequel.

Our work has reached the point where we subscribe to the antienzyme theory. We believe that the action of sulfonamide is a direct one on enzyme systems depending for its effectiveness on factors of environment, and that the phagocytosis is a secondary phenomenon which plays its part in the usual fashion after bacteriostasis has been effected.

We have outlined above a mode of action based on our own chemical and laboratory findings as well as upon the contributions of many other investigators. We cannot stress too greatly the significance of our observations with regard to the activation or potentiation of the sulfonamides by oxidizing agents. We believe that not only does this offer an enhanced method of treatment, but it substantiates the anti-catalase theory and gives much credence to the observations upon which it is based.

COMMENT

The writer realizes only too well that his attempt to describe the experience of several years' work in a paper of this scope offers many difficulties in bridging the gap between multiple observations and unified concepts. Repetition in some places has been unavoidable for the sake of continuity and completeness.

However, several basic concepts arise from the welter of findings: *The most effective local antibacterial agent is a com-*

bination of sulfanilamide and sulfathiazole rendered more effective by an oxidant. Depending upon the nature of the wound or infection, a choice of powder, ointment, paste, jelly, solution or impregnated gauze can be prepared. The activating agents of choice vary with the vehicle. Thus for the powder form, zinc peroxide is favored; for ointment and paste, azochloramid and zinc peroxide are chosen; for solutions, iodine, azochloramid and potassium permanganate may be indicated.

Regardless of the form or content of the above medications, a local excess of the sulfonamides must be made constantly available for absorption by the tissues and to make up for that lost through other means. The addition of a wetting agent such as sodium tetradecyl sulfate will enhance the effectiveness of the suspensions and ointments.

The combination of sulfonamides, oxidizing agent and wetting agent is the key for the most effective local antibiotic mechanism. It has been shown that this form may vary from solution to suppository. It is obvious by now that the entire range of bacterial infections, in as much as they are concerned with surgery and its branches, must of necessity be reconsidered in the light of the new era of activated sulfonamide therapy.

The treatment of war wounds has been and will be still further modified as progress in this field of active chemotherapy continues. Every combatant should carry potentiated sulfonamide powder for immediate use. To wait until the patient reaches the evacuation or base hospital is to wait too long. A sharp decline in gas gangrene, amputations and in the complications subsequent to suppuration can be anticipated.

CONCLUSIONS

1. The sulfonamides have been shown to be effective by local application in the treatment of a wide variety of wounds and wound infections.

2. The combination of sulfanilamide and sulfathiazole—in local use—is more effective than either one alone.

3. Wound healing is not appreciably inhibited by the presence of sulfonamide drugs.

4. The sulfonamides are absorbed from wounds into the general circulation. This has been demonstrated by serum determination.

5. Idiosyncracy to local use is rarely encountered.

6. Local applications are effective in the form of solutions for irrigation, in wet dressings, powders, ointments, pastes, suspensions and medicated gauze depending upon the anatomical and pathological characteristics of the lesions.

7. Bacterial action is inhibited more completely by simultaneously contacting the bacteria with a sulfonamide compound while creating an oxidation environment at the point of contact.

8. The potentiation of the sulfonamides by this method is far greater than would be expected from a simple additive phenomenon.

9. This phenomenon of sulfonamide potentiation is not only antibacterial but it is antibiotic with regard to other unicellular organisms such as ameba, paramecia, trichomonads, spermatozoa and certain fungi.

10. Clinical and laboratory observations with the "potentiated" sulfonamides indicate that the mode of action of sulfonamide medication is a direct attack on the bacterial cells. An explanation for this mode of action has been described.

11. An extended field of investigation has been opened by the discovery of the principle of sulfonamide potentiation by means of oxidizing agents.

12. The ideal surgical antiseptic, harsh to bacteria and kind to tissue, has been approximated.

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Frequent dressings of wounds in connection with compound fractures are unnecessary. The patient should be splinted and dressed in such a way that he is not exposed to secondary and mixed infection by postoperative dressings, irrigations, or wet antiseptic packs.
From—"Wounds and Fractures"—by H. Winnett Orr (Charles C. Thomas).

PILONIDAL CYSTS IN THE ARMY

A REPORT OF THIRTY CASES OCCURRING IN NINETY-SEVEN DAYS AT FORT SILL, OKLAHOMA

LIEUT. COL. WILLIAM J. PICKETT, M.C. AND FIRST LIEUT. ARCH J. BEATTY, M.C.
FORT SILL, OKLAHOMA

INTRODUCTION

DURING the months of August, September, November, and the first five days of December, 1941, thirty cases of pilonidal cyst were seen on the surgical service at the Station Hospital at Fort Sill, Oklahoma. Thus, one case was seen every 3.23 days.

Fort Sill is an Army post which had an average population of approximately 30,000 officers and enlisted men during this study. The calculation of the exact incidence was well nigh impossible due to the shifting nature of the population, but the approximate incidence was 0.1 per cent. The white, Negro and American Indian races were all represented in the population, and no cases were seen in the Indian and only one in the Negro race.

DEFINITION

The term, "pilonidal cyst," is applied to a congenital cyst which is found external or posterior to the sacrum and coccyx. It is sometimes known as a pilonidal sinus or fistula, a sacrococcygeal dermoid or a sacrococcygeal cyst, a coccygeal fistula, a postanal dermoid or a postanal dimple. The term, "pilonidal," is derived from the Latin words "pilus," which means hair, and "nidus" which means nest. Pilonidal cysts are epithelial-lined sacs, usually with one or more cutaneous openings situated in the midline of the sacrococcygeal area.

ETIOLOGY AND INCIDENCE

The etiology of pilonidal cysts has never been definitely settled. The condition was first described by Warren in 1867. He thought it was due to a reversed hair follicle. In 1887, Tourneux and Herrmann advocated the theory that the cyst originates due to the persistence of coccygeal vestiges of the neural canal. If this theory is true, the possibility of causing a meningitis always exists when surgery is done in this region. From 1882 to 1886, Lannelongue advocated the theory that it is a process of ectodermal invagination due to faulty median skin agglutination of the sacrococcygeal region. Another interesting explanation of its etiology is advocated by Stone. He explains it from a standpoint of evolution and thinks that it is a vestigial structure analogous to the preen gland of birds.

There are very few satisfactory statistics covering the incidence of pilonidal cysts and one really does not have much of an idea as to how common it really is. Bellevue Hospital, in New York City, reports 288 cases on its surgical service in ten years. The University of Pennsylvania out-patient clinic had a percentage of 0.9 per cent. In a general hospital for veterans the percentage was quoted as 0.5 per cent. However, thirty cases occurring in ninety-seven days at the Army camp of Fort Sill suggests that it must occur more commonly than the above figures show, or that trauma plays a very common exciting factor. The patients in this series were all young, healthy, adult males who were engaged in vigorous activity such as any army camp demands.

It is interesting to note that pilonidal cysts occur in men three times as often as in women. It very rarely occurs in negroes and no cases have been reported in Mongolians or American Indians. The condition is not hereditary but several

cases occurring in the same family have been reported. It usually occurs in early adult life.

SYMPTOMS AND DIAGNOSIS

Most of our cases were seen in the acute stage. The patient was admitted with swelling and inflammation in the sacrococcygeal region. They complained of pain throughout the lower back region which would vary from a mild throb to severe pain which radiated down the thighs which made it very painful to walk or sit down. There was a discharge from the sinus which varied from a seropurulent discharge to frank pus. This discharge was very irritating to the surrounding skin and often caused a severe pruritus. This latter complaint we found most interesting and it stresses the importance of considering a pilonidal sinus in the differential diagnosis of "pruritus ani." There may be chills and fever.

Our patients who were chronic cases complained of a dull back ache, which was aggravated by exercise and recurrent abscess formation. The chronic cases were much longer in healing and these patients had more pain than those who complained of the condition for the first time. Thus, it is imperative to handle the case correctly from the start and to show the patient why surgery is needed.

The diagnosis of pilonidal sinus is relatively simple. However, it is often confused with other conditions occurring in the same area. The location of one to several sinus openings several inches above the rectum and in the midline in the sacrococcygeal region should suggest a pilonidal cyst. Often there is a hair protruding from these openings, and the opening will probe upward whereas a rectal fistula will probe downward and into the rectum. However, a sinus opening in this region should indicate a thorough history and proctoscopic examination before surgery is attempted. Various opaque dyes have been devised so that the cyst and its ramifications can be studied by *x*-ray.

DIFFERENTIAL DIAGNOSIS

The most common conditions which are confused with pilonidal cysts are osteomyelitis, tuberculosis or syphilis of the sacrum and coccyx. Thus, every case should have an *x*-ray of the sacrococcygeal vertebrae and a chest plate taken and a blood Wassermann test made. Also to be considered in the differential diagnosis are anal, or rectal fistulas, sebaceous cysts, pyogenic infections, lipomas, teratoma, fetal implantations, traumatic dermoid, implantation cysts, anthrax and actinomycosis.

PATHOLOGY

The specimens were very similar grossly and consisted in blocks of tissue measuring about 12 by 2 by 2 cm. There were from one to four sinus tracts leading into the main cystic sac which was often filled with silky hair or frank pus.

Histologically, the picture was essentially the same in all cases. The main tract consisted of granulation tissue rich in blood vessels and exudate of an acute or subacute nature with wandering cells usually predominant. Lying loosely in the stroma were numerous hairs surrounded by giant cells of the foreign body type. The hairs were devoid of sheaths. The cyst and the adventitious branches were lined with stratified squamous epithelium.

TREATMENT

The primary objective of any form of treatment is to cure the patient permanently in as short a time as possible. Thus, in treating pilonidal cysts the entire sinus and all of its ramifications must be completely excised so that the condition will not recur.

Several different technics have been developed for the relatively clean cases. They all require complete excision of the cyst and its ramifications but differ in whether the wound is packed open, or whether it is partially or completely closed. Various sclerosing technics have been described but none were used in this series.

Our cases were handled by excision and open packing.

Great care must be taken before excision to make sure that the primary infection has subsided. If the infection is mild, local hot packs are applied to the area until the inflammation has become quiescent. If an abscess is present, it is incised and drained.

Radical surgical excision *en masse* of the tract-bearing area including a wide zone of normal tissue will result in a cure in about 75 per cent of the cases. Primary closure without drainage failed to show any superiority to partial closure or open packing in a series of fifty-four cases reported by Silverman. Our method of wide excision and packing gives results comparable to those of Silverman's. However, not enough time has elapsed for an adequate follow-up in our series.

Our patients were fed a full diet up until the morning of the operation. Enemas were given the night before and the morning of the operation. Each patient was given 1½ gr. of a barbiturate the night before surgery and at 6 A.M. on the morning of the operation. Morphine gr. ¼ and atropine gr. 1/150 were given just before surgery.

Spinal anesthesia was used exclusively in all but two cases, 100 mg. of novocaine being used in each case. We feel that there is little danger of carrying organisms into the spinal canal if the needle is inserted above the infected area after the skin over the area has been well cleansed. Local anesthesia seems contraindicated for three reasons: (1) The needle when passed through infected tissue into the surrounding normal tissue mechanically spreads the infection and necessitated wider excision; (2) novocaine as a local anesthetic neutralizes the sulfanilamide powder used in the wound postoperatively, and (3) the spinal anesthetic gives much greater relaxation in the area. This latter is essential to successful surgery because some of the ramifications of the sinus tract may be extensive.

The patient is placed prone on the table with the head and foot of the table lowered twenty degrees. The operative site is cleansed thoroughly with soap and water and then painted with Scott's solution. All of the sinus openings are injected with methylene blue under moderate pressure using a blunt cannula. The approximate size of the cavity is estimated by the amount of methylene blue that is used.

Different operators disagree on the efficacy of methylene blue. We believe that it enabled us to remove more of the diseased area although it is not specific for diseased tissue. The dye will not always enter all of the sinuses. However, we believe that its use is a distinct aid.

Two elliptical incisions are made approximately one-half inch lateral to the most lateral sinus opening and carried through the skin, subcutaneous tissue and fat down to the fascia lining the coccyx and sacrum. Great care is taken not to enter the sinus cavity or to miss any of the infected tissue. This tissue is then removed as a block. If methylene blue is found on the fascia covering the coccyx and sacrum, the infected fascia is excised and the bone is curetted. At times it may be necessary to remove the coccyx.

All bleeding vessels are carefully ligated. Bleeding in the fascia overlying the coccyx and sacrum is best controlled by suturing, as ligatures often slip off when the patient moves about. It is essential to have a dry postoperative field because of the proximity of the wound to the rectum and of the excellent culture medium offered by blood.

Sulfanilamide powder is then dusted into the wound. It has been shown that the local use of this drug will give a concentration of 800 to 900 mg. in the surrounding tissue. The wound is then packed open with iodoform gauze and a sterile dry dressing is placed over the packing described. Adhesive tape is then applied tightly across the entire area to help prevent postoperative bleeding which did occur in two of our cases.

The patient is then placed prone in bed with the foot of the bed elevated for six hours. This was done to help prevent the postoperative headache which occasionally follows a spinal anesthetic. Codeine, aspirin and a barbiturate were used to control the

postoperative pain and restlessness. The patient is encouraged to sit by the side of the bed the morning following surgery and to walk to the latrine and about the ward. He is sent to the hospital mess on the third postoperative day and encouraged to take light exercise. No effort is made to constipate him and every effort is made to encourage the taking of exercise. One of our patients, who was a commissioned officer, took charge of the artillery firing on his fifth postoperative day.

The wound cavity is repacked firmly every third day with iodoform gauze, and the external dry dressing changed daily or as needed. Sulfanilamide powder is dusted into the wound cavity with each repacking and we believe that this played the major rôle in preventing postoperative infection. So far, none of our series has developed a postoperative infection. Occasionally 5 per cent silver nitrate is used to stimulate the growth of granulation tissue. The wound cavity heals in from eight to eleven weeks.

Block excision of the tract, with a transplanted pedicle flap to fill in the resultant cavity, has not seemed practical to us. The purpose of this operation is to place the scar lateral to the midline in order to prevent any tenderness from sitting on a tight, hard scar. None of our patients gave this complaint, and we believe that this operation just opens a new area for potential infection.

At this time we plan on giving a dipilatory dose of *x*-ray over the skin of the region postoperatively. This would serve to inhibit hair follicle activity to whatever extent this may be a cause of recurrence.

CONCLUSIONS

1. Thirty cases of pilonidal cysts occurring in ninety-seven days in a representative army camp are reported.

2. The high incidence of this entity in such surroundings indicates that trauma plays an important rôle in its etiology.

3. Spinal anesthesia was the anesthetic of choice.

4. Surgical procedure consisted in wide excision and open packing.

5. Sulfanilamide powder was used topically in all cases with no postoperative infection encountered.

6. Postoperative management consisted in getting the patient out of bed as quickly as possible. Normal bowel habits were encouraged.

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RUPTURED UTERUS FOLLOWING THE SPINELLI OPERATION FOR INVERSION OF THE UTERUS*

CESAREAN HYSTERECTOMY: RECOVERY OF MOTHER AND BABY CASE REPORT

LOUIS E. PHANEUF, M.D.
Professor of Gynecology, Tufts College Medical School
BOSTON, MASSACHUSETTS

PUERPERAL inversion of the uterus is a rare complication of pregnancy. In a recently published table by Bland and Goldstein,[1] the range was from 1 in 10,000 to 1 in 400,000 cases, whilst the Leningrad Lying-In Hospital had reported 0 in 250,000 cases. Puerperal inversion of the uterus has not occurred in my hands, but, from 1924 to 1941, six women with this disorder have been referred to me for treatment. One was seen shortly after the accident, the placenta was removed and the uterus reinverted. Three were seen in the so-called chronic stage of the lesion, after involution had taken place, and were treated by the Spinelli operation, anterior colpohysterotomy. One woman had an abdominal panhysterectomy because of gangrene of the uterus and hemorrhage, and still another a vaginal hysterectomy for the same reasons. Since two of these six patients had hysterectomies, there remained four who could subsequently become pregnant, but it has been encountered in only one instance, this patient being among those who had previous Spinelli operations. Her case forms the basis of this report. (Case v.)

CASE REPORT

Mrs. M. B., aged thirty, a secundipara, was admitted to the Carney Hospital on May 25, 1938. She had had two children, both delivered by forceps, the last infant having been born ten weeks before admission. For seven days preceding admission she had had a constant brownish discharge and hemorrhages, the hemorrhages being especially severe when straining at stool. On admission an examination was made; the vagina was filled with blood clot, the equivalent of two handfuls. After the evacuation of the clots a puerperal inversion was discovered. On inspection the striking feature was the marked pallor. The hemoglobin was 45 per cent, the red cell count 2,770,000 and the white cell count 6,200. During the afternoon of May 26 she was given a blood transfusion by the citrate method, 500 cc. of blood being administered. She was operated upon on May 27, 1938, under spinal anesthesia, a typical Spinelli operation being performed. Drainage in the anterior and posterior cul-de-sacs was instituted. A second blood transfusion was started as soon as the patient was returned to bed. Again, the citrate method was used and 500 cc. of blood was given, a total of 1,000 cc. being administered. She stood the operation well. She had a mildly febrile convalescence. The temperature was 102°F., the pulse 130 and the respirations 34 on the first postoperative day, but all three had become normal by the tenth day. She was discharged from the hospital on June 11, 1938, seventeen days after admission, her condition then being entirely satisfactory.

On July 18, 1938, she was examined in the office, at which time the abdomen was soft, relaxed, tympanitic, and there were no masses or areas of tenderness. The perineum was relaxed, the cervix was healed, the uterus was normal in size, in second degree retroversion, and the adnexa were normal. The cervix, as seen through a speculum, showed good healing. The drainage areas, as well as the anterior vaginal incision, were healed, and there was no cystocele or rectocele. The blood picture was normal and the operative result entirely satisfactory.

* From the Departments of Gynecology and Pathology, Tufts College Medical School, and the Departments of Obstetrics and Gynecology, and Pathology, Carney Hospital, Boston.

The patient next reported to the office on February 24, 1941. Her last menstrual period had occurred from July 9 to July 13, 1940. Her

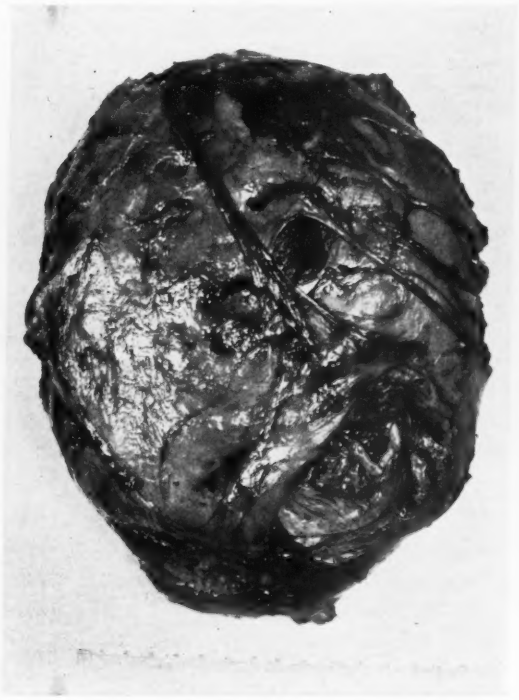

Fig. 1. Photograph of anterior surface of uterus. The serosal surface is ragged and the long tags of edematous serosal and fibrous tissue are evident. In the upper portion there are two dark fusiform areas representing the points of rupture. The dark maternal surface of the placenta is just visible protruding slightly through these openings. In the lower right portion the area of recent surgical incision is seen. Through this gaping area the glistening fetal surface of the placenta is evident. The wide dark isthmus is present below.

confinement, by dates, was expected for April 15, 1941. Although advised to the contrary, at the time of her discharge from the hospital, she had had no prenatal care during this pregnancy. However, only for a mild trichomonas vaginalis infestation, for which treatment was prescribed, examination showed her to be in good physical condition. The pelvimetry revealed an ample pelvis, and all measurements to be within normal limits. The uterus was 32 cm. in height, measuring from the symphysis pubis; the fetus was well formed, and presented by the vertex in the left occipito-anterior position; the fetal heart tones, which were heard in the left lower quadrant of the abdomen, were of good quality and the rate was normal; the blood pressure was 134 systolic and 90 diastolic; and the urine showed no abnormal elements. *A cesarean section was advised because of the previous long incision which extended from the fundus to the os externum of the cervix.* She was instructed to report every two weeks for examination, but her next visit was made on March 17, 1941, three weeks later. The uterus was 38½ cm. above the symphysis; the fetus presented by the vertex in the left occipito-anterior position; the fetal heart tones were heard in the left lower quadrant, and were of good quality, and the maternal heart was normal. There were slight varicosities of the left leg but no edema. The urine was acid and showed no sugar and no albumen. *The date of the cesarean section was set for March 31, 1941, in order to avoid the strain of the last two weeks of gestation on the uterine scar.*

Fig. 2. Photograph of the opened uterus showing internal surface with attached placenta. The shining fetal surface, the bilobed character and the prominent vessels of the placenta are evident. The marginal attachment of the cord is seen in the upper portion. The thick myometrium is well shown in cross section on the left. The points of rupture, being covered by the placenta, are not visible in this view.

On March 28, 1941, she awoke in her home, twenty miles outside of Boston, at 6 A.M. but did not get out of bed. At 6:15 A.M. a sharp pain was experienced in the abdomen which was quickly referred to the right shoulder. She was seen by her family physician who immediately sent her to the Carney Hospital in an ambulance. Upon her admission to the hospital it was obvious that she had a ruptured uterus. She was in good condition, had but moderate shock and was directly prepared for a laparotomy.

Operative Procedure: Fifteen cc. of 1 per cent solution of neutral acriflavine in glycerine were instilled in the vagina. The urinary bladder was

catheterized. The abdominal cavity was entered through a median suprapubic incision, extending from the symphysis to the umbilicus.

Fig. 3. A low magnification showing a transverse section through the wall of the uterus above and the attached placenta below. This section is taken in the line of medial scarring 3 to 4 cm. distal to the area of laceration. Along the upper surface of the uterus, abundant tags of scar tissue are easily recognizable. The v-shaped depression corresponds to the depression seen grossly on the surface of the uterus in the area of former incision. The apex of the v may be followed into the substance of the uterus leading to an area of scarring. This area is approximately one-third as thick as the myometrium elsewhere. There is actually much less muscle in this area. There is an artificial line of cleavage separating uterus from placenta. In the mid-zone between uterus and placenta the vessels are dilated, and one contains a recent thrombus. × 5.

Considerable free blood was found in the peritoneal cavity. A few fine peritoneal and omental adhesions were ligated and resected from the posterior surface of the uterus. A longitudinal incision was made in the anterior wall of the uterus, and a male fetus, presenting by the vertex, and weighing 8 pounds, 10 ounces (3,933 Gr.) was delivered. The baby was resuscitated without difficulty. The uterus was turned out and inspected, and a rupture in the previous scar, about 2½ cm. in diameter was found at the fundus. There was a weak point in the scar about 8 cm. below the area of rupture, the rest of the scar having held together. The placenta was left *in situ*, and a supravaginal hysterectomy, with the conservation of the adnexa, was performed. A small cigarette drain was introduced in the vagina through the cervical canal. All pedicles and raw areas in the pelvis were covered over by peritoneum and the ovaries were suspended to the round

Fig. 4. A higher magnification showing a portion of Figure 3 comprising the serosa and myometrium in the area of scar formation. The thickened and ragged serosa is sharply demaracated from the underlying muscularis. A narrow line of scar tissue may be traced from the serosa into the substance of the uterus where it expands in a somewhat irregular area of scar formation. × 13.

ligaments. A cigarette drain was placed in the posterior cul-de-sac and allowed to come out at the inferior angle of the incision. The sigmoid was brought down to roof over the pelvis. A large blood clot, extending from the liver to the pelvis, and filling the right gutter was removed, the liquid blood being left in the peritoneal cavity. The incision was closed in layers. The patient was returned to her bed in good condition, where she was given a blood transfusion of 500 cc. using the citrate method. At this time both mother and baby were doing well.

The specimen was submited to Dr. H. E. MacMahon, Professor of Pathology at Tufts College Medical School, to whom I am indebted for the pathological report and photographs.

Gross Description. The specimen consisted of an enlarged edematous gravid uterus from which the infant had been removed. The uterus measured 18 cm. in length, 17 cm. in width and 8 cm. in thickness. It had been removed at the level of the isthmus where it measured roughly 6 cm. in width and 2 cm. in thickness. The canal here was lax and admitted the tips

of three fingers. The lumen in this area was approximately 3 cm. in diameter. The right side of the uterus was somewhat more distended than the left. The serosal surface in the region of the fundus and along the anterior surface, especially in the region of the midline was ragged, and long membranous tags of edematous serosal and fibrous tissue could be picked up easily with the fingers.

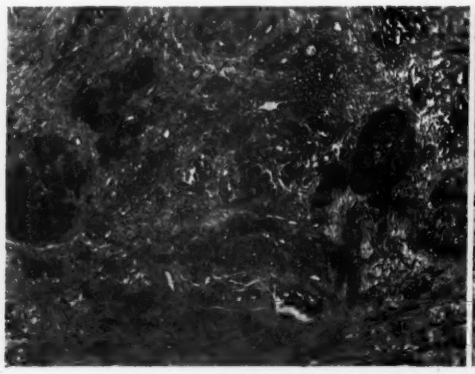

FIG. 5. A still higher magnification showing a section of the myometrium seen in Figures 3 and 4. This is taken in the area of scarring. Several scattered muscle bundles composed of hypertrophied muscle fibers stand out conspicuously against a background of edematous connective tissue. In the very center of the field individual muscle fibers of a muscle bundle show atrophy and degeneration. There are areas of edematous scar tissue staining darkly in which collagen fibers show swelling, fragmentation, and an alteration in tinctorial reaction—findings consistent with autolysis. × 131.

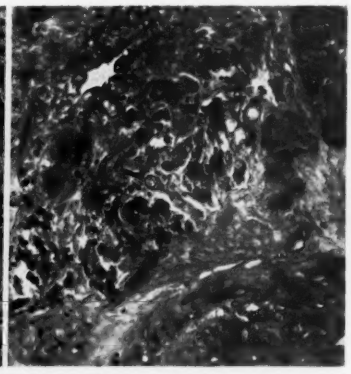

FIG. 6. A still higher magnification from the area of scarring of the myometrium seen in Figures 3, 4 and 5. In the center of the field individual muscle fibers show atrophy, degeneration, necrosis and infiltration with histiocytes. Phagocytosis of necrotic muscle is taking place. The adjacent collagen is swollen and at one or two points shows disintegration. Some of the nearby muscle fibers are large and well preserved. Others are small and atrophic. × 200.

The most striking gross lesion was the presence of two roughly fusiform and gaping openings in the midline in the region of the fundus and anterior surface of the uterus. Each of these openings measured roughly 3 cm. in length and 2 in width. Each was filled with the dark red granular surface of bare placenta. The placental tissue was unusually soft in this area and somewhat separated. These two perforations were separated by a thin and almost transparent strip of muscle and serosa which measured about 2 cm. in width. A probe could easily be passed from one perforation to the other. The placental tissue here was only loosely attached to the uterine wall. The margins of these tears were somewhat irregular and the uterus here, as it reached the actual opening, became transparent and paper-thin. The lateral margins of the uterus were represented by freshly dissected surfaces in which vessels, the stumps of tubes and round ligaments could be identified.

There was a recent surgical incision through the anterior wall of the uterus, 3 cm. in length. This began 2.5 cm. above the lower dissected surface in the midline, and extended somewhat obliquely upward and to the left. The wall of the uterus in this area of incision was lax, grayish pink and edematous and varied from 1.5 to 2 cm. in thickness. This opening gaped slightly, exposing a small segment of bare dark purple placenta. This was a portion of the maternal surface of the placenta facing the anterior wall. The membranes in this area were torn and were rolled up along the free edge. Approximately 2 cm. of cord projected through this surgical opening. It was possible to insert one's hand into the cavity of the uterus through this recent line of dissection. The sac was everywhere intact except in the region of this opening. Even at the lower dissected surface the sac completely closed off the isthmus. With the hand within the amniotic cavity, it was

possible to trace the limits of the still attached placenta. The placenta was somewhat bilobed and was attached over the anterior surface of the uterus, over the fundus and over a large portion of the posterior wall. Somewhat more of the placenta was to the right of the median line. Both lateral surfaces of the uterus were free. With one hand in the amniotic cavity, it was possible, without any pressure, to bring a palpating finger up through the rent in the anterior uterine wall, the only tissue separating the finger from the external surface being the amnion, chorion and few friable tags of villi. The placenta was already detached over an area on the anterior uterine wall about the size of the palm of one's hand. This corresponded to the zone between the lower tear and the recent surgical incision.

The extent of the placenta could be seen more clearly after the uterus was opened. The placenta was somewhat bilobed and the cord was attached near its narrowest portion.

Several sections were taken through the fundus in the midline and at other points including the margins of tear and rupture. In the region of the fundus in the midline there was a depressed scar-like line covered by loose edematous adhesions. When this was sectioned it was found to be gray, firm, leather-like, and about 0.5 cm. in width, contrasting sharply with the 2 to 3 cm. of thickness of the surrounding uterine musculature. The placenta was attached in this area just as firmly as in the nearby and more healthy zone. A section taken through the area of the tear showed that the wall of the uterus gradually became thinner as it reached the line of rupture. The placenta here was somewhat loosely attached.

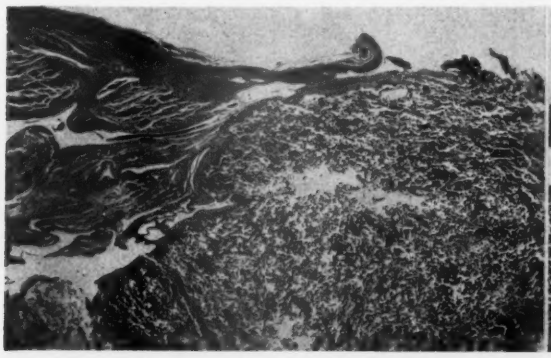

Fig. 7. A low magnification of a section taken to include uterus and adjacent placenta along the line of uterine rupture. The thick hypertrophied wall of the uterus is seen to taper gradually from left to right where it is finally represented by a thin band of muscle fibers. The relation of the placenta to the uterus is well preserved. There is no unusual ingrowth of trophoblastic tissue. A narrow zone of decidua cells separates muscle from the chorionic tissue. The large blood spaces in the wall of the uterus stand out conspicuously. × 5.

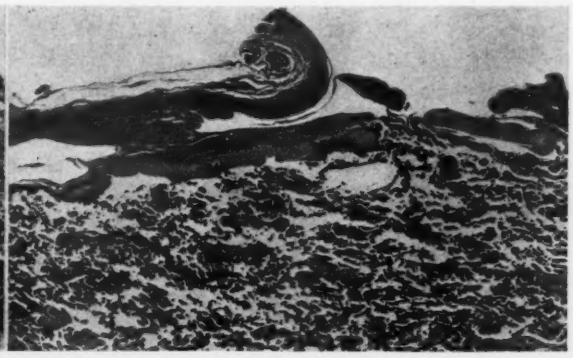

Fig. 8. A higher magnification showing that portion of the field as seen in Figure 7 just along the line of rupture. It is apparent that rupture has occurred in this area at a point where a sinus becomes continuous with the intervillous spaces. The wall of the sinus adjacent to the placenta shows a channel through which chorionic villi may be easily traced. A small tab of red blood cells and fibrin is loosely adherent at this point. The wall of the sinus may be followed through to an abrupt end that is torn and curled back against the adjacent serosa. It is obvious that at this point of rupture the only partition between placenta and peritoneal cavity is the single wall of a blood sinus and its overlying somewhat edematous serosa. The underlying placental tissue is well formed. The decidua stands out clearly. A narrow band of fibrin, Nitabuch's membrane, separates decidua from the overlying muscularis. There is no unusual invasion. The villi are well formed. The intervillous spaces are free. × 13.

Gross Diagnosis. A gravid uterus showing a double midline rupture at the site of a former midline scar (Spinelli operation three years before); old healed perimetritis with scarring of the serosa; Porro cesarean specimen of uterus.

Microscopic Findings. A gravid uterus with placenta attached. The placenta was mature,

well developed, and showed no evidence of any pathological condition. Several sections were prepared from the wall of the uterus to include the hypertrophied wall, the old midline scar and the margin of rupture. The myometrium was well developed. There was an old midline scar containing small bundles of hypertrophied muscle fibers, and fragments of old suture material. There were foci of lymphocytes and plasma cells in this area of scar formation.

Of special interest in this scar area was the presence of edema, swelling, necrosis, disintegration and dissolution of collagen. Isolated muscle fibers and clusters of muscle fibres showed vacuolization, atrophy and gradual disappearance.

Sections taken just at the line of rupture showed a stretching and rapid thinning out of myometrium. At the exact point of rupture in one area a large venous sinus was torn across.

Some of the arteries adjacent to the scar and rupture showed an unusual degree of intimal sclerosis and narrowing of the lumina.

Microscopic Diagnosis. This showed repair of old surgical incision with scar formation, degeneration of scar, rupture of scar, with hemorrhage: pregnancy. *Note:* I believe the changes in the scar adjacent to the actual area of rupture gave one a good impression of why rupture had occurred. There was a recent degenerative change going on in this scar with digestion of collagen. I believe that this process had been of particular importance in the mechanism of rupture. There was no indication that the placenta was unusually invasive and no evidence of malignancy. (Examined by H. E. MacMahon.)

Convalescence. This was free from complications. There was no undue rise of temperature, pulse or respirations. The two drains had been removed by the fifth day, and the convalescence was that which follows a simple hysterectomy. The patient was discharged on April 26, 1941, twenty-eight days after operation, and the following discharge note was made: The abdominal incision, including the drainage tract, is healed throughout. There is no induration or tenderness. The vaginal examination shows a relaxed perineuum but no cystocele or rectocele. The cervix, through which a drain had been inserted, is closed, it is parous, relaxed, healed, without erosion or ectropion. The uterus has been removed supravaginally, the adnexa feel normal, and there were no masses or areas of tenderness in the pelvis.

The baby was gaining weight rapidly on a formula.

On June 5, 1941, the patient reported to the office for further examination. The abdominal and vaginal findings were those of April 26, 1941. The baby then weighed thirteen pounds (5,928 Gr.), and was doing well. The mother's general health was excellent.

SUMMARY

The woman who has had a Spinelli operation in the treatment of inversion of the uterus is exposed to the danger of rupture of the uterus in a subsequent pregnancy, because of the existence of a scar extending from the uterine fundus to the os externum of the cervix. One on whom I had performed this operation on May 27, 1938, reported to me in late pregnancy. It was decided to deliver her by cesarean section, and the date of the intervention had been arranged for two weeks before the expected term in order to avoid the strain of the last two weeks of gestation on the uterine scar. Three days before this appointed date, without any effort on her part, and while she was in bed, her uterus ruptured. She was transferred to the hospital as soon as possible where a cesarean-hysterectomy was performed, following which a blood transfusion was administered. The convalescence was uncomplicated and the mother and baby were discharged from the hospital in good condition.

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ACUTE PERFORATED PEPTIC ULCERS

AN EIGHTEEN-YEAR SURVEY

H. LEWIS BERSON, M.D.
BROOKLYN, N. Y.

IN a recent review of the subject of acute perforated ulcers, Eliason and Ebeling collected 5,061 cases from various clinics, both here and abroad with a mortality for all cases of 23.7 per cent. Their paper has prompted an investigation into all acute perforations encountered over an eighteen-year period (1923 to 1940) at a metropolitan hospital (Jewish Hospital of Brooklyn) where the surgery was performed by thirty surgeons including the resident staff. The statistics were collected from both the private as well as the ward records.

It is true that the literature is replete with reviews on this subject, but only by frequent and repeated analyses can a method of procedure in this acute emergency be crystallized.

GENERAL

The total admissions to the medical and surgical divisions during this period amounted to 132,115. There were 154 consecutive cases of acute perforated peptic ulcers or an incidence of one case in 858 admissions. (Table 1.) The greatest frequency occurred in 1926, with one in 426, and the lowest in 1933, at which time there was only one perforation in 2,063 admissions. Three patients were admitted in extremis and died without operation.

AGE

The youngest patient was seventeen years of age with a known history of ulcer since the age of eight. He subsequently had a gastroenterostomy performed for obstruction. Following this, he developed signs of both a penetrating duodenal ulcer and a gastrojejunal ulceration. A subtotal gastrectomy of the Hofmeister type was done recently (March, 1941). Six patients were under twenty years of age. The oldest, seventy-one, had a prepyloric gastric perforation and recovered following simple closure. There was no preponderance in any one age group. (Fig. 1.) Perforations were less frequent under twenty and over sixty years, with an equal distribution in the intervening decades. Stern, Nessa and Perkin have recorded the case of a two-day old infant, who was operated upon for perforated gastric ulcer. Death was due to peritonitis.

TABLE 1
HOSPITAL INCIDENCE

Year	Admissions	Perforations	Incidence
1923	4,803	9	1:530
1924	5,549	7	1:790
1925	5,163	13	1:400
1926	5,125	12	1:425
1927	4,976	8	1:620
1928	4,977	4	1:1240
1929	7,095	11	1:645
1930	7,848	12	1:650
1931	8,592	11	1:780
1932	8,684	7	1:1240
1933	8,272	4	1:2070
1934	8,281	6	1:1380
1935	8,851	9	1:980
1936	9,148	5	1:1830
1937	8,782	8	1:1100
1938	8,357	6	1:1390
1939	8,806	10	1:880
1940	8,806	12	1:735
Total....	132,115	154	1:858

SEX

There is a marked preponderance of this condition in the male. (Fig. 1.) Eliason and Ebeling found the ratio to be 31:1. Barber presented a greater frequency with one female to five males. Unique in the statistical reviews are Sallick's seventy-four and Brahms' sixty-two perforations, all occur-

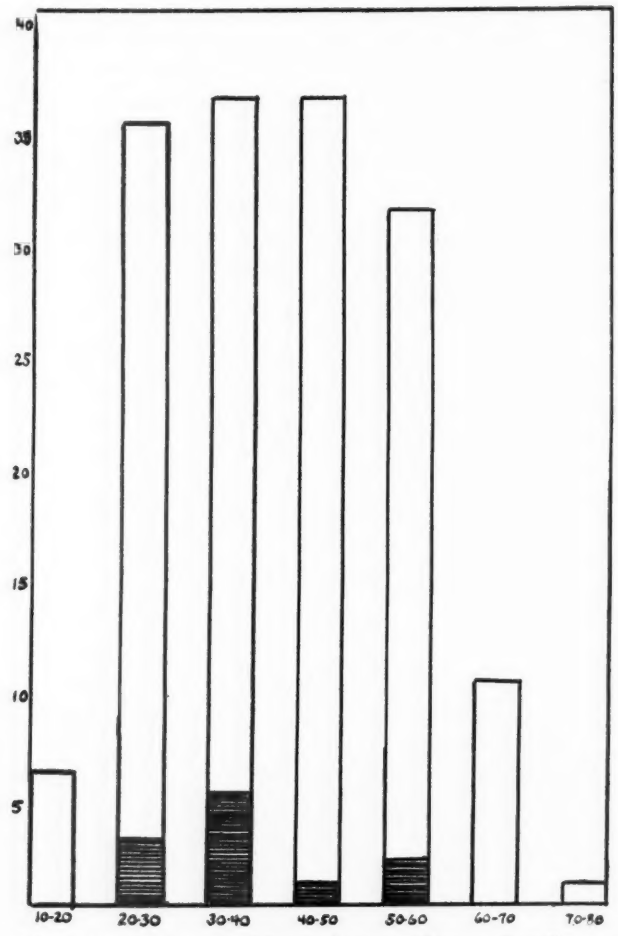

FIG. 1. Age and sex incidence: heavy column—female, 11; blank column—male, 143.

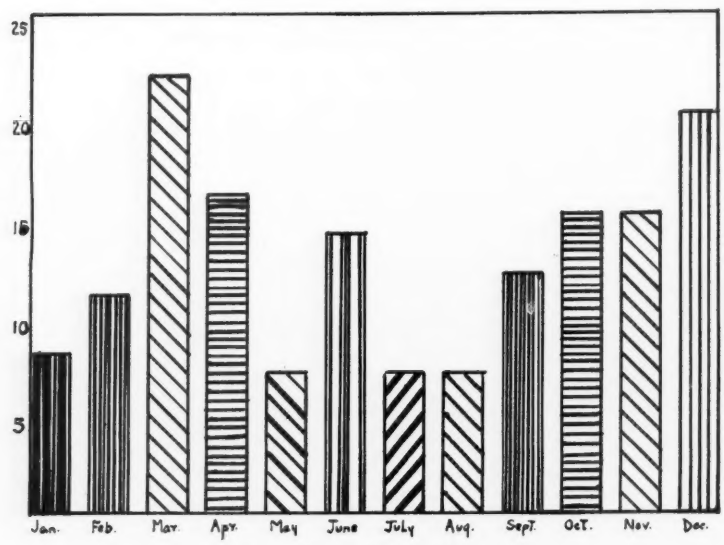

FIG. 2. Monthly incidence.

ring in men. In this series of 154 cases, eleven were found in women and 143 in men, a ratio of 1:13.

SEASONAL INCIDENCE

There was a mild seasonal and monthly variation. (Fig. 2.) May, July and August were the low points in this series with seven perforations. The frequency in the Spring and Fall was two and three times as great. There were twenty-two cases in March and twenty in December. This apparent preference during cold weather did not hold for January, at which time only eight occurred. Nor is the statement entirely true that few perforations take place during the warm season when we note that fourteen patients came to operation in June.

PREVIOUS HISTORY

Twenty-four (15.6 per cent) gave no previous ulcer history and became aware of the presence of the ulcer only by the occurrence of the perforation. The others (84.4 per cent) had had symptoms suggestive of ulcer or had been treated for an ulcer for periods varying in duration from a few weeks to twenty-five years. Only eight had had roentgen ray evidence of an ulcer. Five had had *x*-rays taken but no lesion was found at the time. Six patients were on a diet, but in general the medical therapy was inadequate. About 50 per cent resorted to alkalies or food for the relief of the symptoms. Perforation can occur even in the presence of an adequate medical régime. This was found to be the case in twenty-seven of fifty-six patients observed by Eliason and Ebeling. In Brown's series of one hundred perforations, fifty were under medical care at the time the catastrophe occurred.

ACTIVITY AND PERFORATION

In many cases no immediately exciting factor could be ascertained. Thirteen were awakened from sleep by the sudden acute pain. Two were driving their automobiles; five were lifting heavy weights; three were straining at stool and two were undergoing a gastrointestinal roentgen investigation at the time of perforation. Only twenty-five patients were occupied in sedentary work. These included lawyers, students, clerks, a musician, an engineer, a broker and a school teacher. The other men were engaged in heavy labor. These were plumbers, longshoremen, painters, machine operators, brick layers and handy men. The women were all occupied with house work.

That trauma can play a part in the causation of perforation is exemplified in the case of a thirty-two-year old houseman who was hit in the epigastrium by the head of a child who ran into him. He felt abdominal pain following the injury, but did not seek medical attention until seventy-two hours later. At this time, he had signs of a general peritonitis and died eight hours following admission. Necropsy revealed the presence of a perforated duodenal ulcer.

TIME INTERVAL AND MORTALITY

Opinion is unanimous that the most favorable prognosis is in the early case. Graham, in presenting fifty-one perforations with but one fatality, attributes this low mortality rate to the fact that the average time interval for all his patients was about seven hours between the onset of symptoms and operation. His excellent results are convincing proof of the necessity of early diagnosis and proper surgical intervention. Fifty-seven patients were admitted within six hours with three deaths (5.2 per cent). With the increase in the time

Table II
TIME INTERVAL AND MORTALITY

Time—Hours	No. Cases	Fatalities	Mortality Per Cent
1–6	57	3	5.2
7–12	48	7	14.6
13–24	23	4	17.3
25–48	10	3	30.0
Over 48	8	6	75.0
Not stated	5	0	
Total	151	23	

interval, the mortality rose with the high of 75 per cent in eight patients operated upon forty-eight hours after perforation. (Table II.)

RECURRENT AND MULTIPLE LESIONS

Only three patients had recurrence of perforations. One had had a gastric ulcer perforation seven years previous to a perforation at the first portion of the duodenum. A second patient had two perforations within four years, supposedly at the same site in the duodenum, and the third suffered two perforations within one year.

The following is an unusual case in which two perforations, one duodenal and the other gastric occurred simultaneously.

CASE I. The patient was a fifty-seven year old man with a known ulcer history of ten years' duration. He was admitted to the genitourinary service for an acute retention of urine. After catheterization, during which about one and one-half liters were removed, his abdominal pain continued. His abdomen was tensely rigid and signs of an acute peritonitis were present. A flat plate of the abdomen at first showed only distended intestine, but a second one the following day revealed the presence of a pneumoperitoneum.

At operation, two perforations were visualized, one in the prepyloric anterior surface of the stomach and the other in the first part of the duodenum. Both were closed with simple sutures. Culture of the abdominal contents showed Staphylococcus aureus and Streptococcus hemolyticus to be present. His immediate postoperative course was good but several days later he developed an erysipelas and signs of uremia and died twenty-one days after operation. Necropsy confirmed the operative findings. In addition, he had renal abscesses, pneumonia and a carcinoma of the prostate.

Perforated ulcers occur usually on the anterior wall of the stomach or duodenum, while bleeding ulcers are more frequent on the posterior wall, particularly in the duodenum. When both signs of perforation and bleeding are present, a search should be made for two lesions. Occasionally, a bleeding ulcer may be quiescent at the time of perforation and may be overlooked at the time the perforation is closed. A situation such as this may not only cause a rather stormy convalescence but can result in a fatality if allowed to continue.

CASE II. A fifty-year old male patient was admitted with a diagnosis of an acute perforation of the duodenum. He had a known ulcer of fifteen years and but little medical therapy. The perforation was found on the anterior wall of the first portion of the duodenum and this was closed with simple sutures and no drainage employed. Culture of the peritoneal contents showed the presence of Staphylococcus aureus and Streptococcus nonhemolyticus. He had a normal convalescence for five days and then began to vomit large quantities of blood. He was treated conservatively with infusions and transfusions and the bleeding ceased. Three weeks after operation he again had several severe episodes of hemorrhage. His blood pressure at this time was 80/50. He was given blood transfusions several times until his pressure reached 114/90. His condition was serious, as he continued to bleed. In the hope of stopping the hemorrhage, he was taken to the operating room. The duodenum was opened and a bleeding ulcer on the posterior wall was found. Attempts to control this were made by several sutures through the base and then a subtotal gastrectomy was performed. He died the following day and necropsy revealed an ulceration through the wall into the superior pancreaticoduodenal artery.

Another unusual finding was the simultaneous occurrence in a fifty-year old male of an acute perforation in the duodenum and an acute hydrops of the gallbladder due to a cystic duct obstruction by a stone. The perforation was diagnosed preoperatively, but the other lesion was unexpected and fortunately not overlooked. The perforation was closed and the gallbladder removed. He made an uneventful convalescence.

DIAGNOSIS

In the majority of patients, the clinical picture is characteristic. The sudden onset of acute pain, usually epigastric in location, that throws the patient into a state of collapse or prostration is typical. He is doubled up into a jack-knife position from which he straightens out only with difficulty and with apprehension that any

movement will increase his suffering. The pain early is present over the site of perforation, but soon becomes general. Reference of pain may be to one or both shoulders which is a good differential point from acute appendicitis. Muscular rigidity is extreme and the patient frequently volunteers the information that he could feel his "belly harden up." The board-like abdomen persists even after the administration of sedatives. The temperature in the early stage is normal or even subnormal. The pulse may be quickened, but seldom goes beyond 90 in the first few hours. Respirations are costal in type and shallow, due to the muscle splinting. Vomiting and nausea were not constant, but occurred in about 50 per cent of the cases. Retching was present in another 25 per cent. None of these symptoms were noted in 25 per cent.

A moderate leucocytosis was usually present and occurred early in the condition. There was a definite relationship between the total white blood count and the mortality. (Table III.) In sixty-eight cases with a leucocytosis of 15,000 or over, the mortality rate was 7.3 per cent. In counts between 10,000 to 15,000, the rate doubled; and when the white cell response was under 10,000, the death rate reached 52.4 per cent.

Table III
Leucocytosis and Mortality

W.B.C. Count	No. Cases	Deaths	Mortality Per Cent
Over 15,000	68	5	7.3
10,000–15,000	41	6	14.6
Under 10,000	21	11	52.4
No count	24		

Obliteration of liver dullness was noted in forty patients. In seventeen others it was definitely absent. The limitations of this sign as a diagnostic aid is obvious. A distended loop of intestine, lying between the liver and the abdominal wall, will produce a tympanitic sound on percussion. Turning the patient on his left side and then percussing the liver in the midaxillary line may be of some help. Generally, this sign is of little value and other findings are of more significance.

Pneumoperitoneum

Roentgen ray evidence of the presence of a pneumoperitoneum has been very helpful in making the diagnosis of a ruptured viscus. This should be taken in the erect and not in the prone position. One patient was delayed twenty-four hours because the flat plate of the abdomen showed no gas under the diaphragm. The exposure had been taken with the patient lying down. A re-examination done the following day with the patient in the erect position showed a small but unmistakable collection of air. A negative film is of no significance, but a positive finding is almost pathognomonic. Johnson advised that the patient be turned first on his left side for a few seconds and then shifted to the erect posture for the exposure. By this method he found a pneumoperitoneum in 83 per cent of forty-two cases of perforated ulcers. During the first fifteen years of this series, the *x*-ray was resorted to on only four occasions, with a positive finding in two (50 per cent). During this period a wrong diagnosis was made in 24.6 per cent of the cases seen. During the past three years, twenty-eight patients with perforations were all properly diagnosed. Roentgen ray visualization was resorted to in twenty, and in sixteen of these, a pneumoperitoneum was noted.

The most frequent errors in diagnosis were acute appendicitis in twenty-three (15 per cent), acute cholecystitis in six (3.9 per cent), of whom four were females, and intestinal obstruction due to malignancy in one case. The correct diagnosis in the entire series was made in 124 (80.5 per cent).

Anesthesia

Spinal anesthesia was employed in sixty-one but had to be augmented in nineteen by some form of inhalation anesthetic. This was caused either by failure to obtain suffi-

cient relaxation or to prolongation of the operation beyond the working time of the spinal anesthetic. This failure of spinal anesthesia to produce the desired effect has been noted by many observers, and different explanations have been offered; none of which, however, proves so adequate or so logical as that which blames faulty technic in the administration as the sole cause of the failure. The high mortality of 25 per cent in those cases in which local infiltration was used is explained by the fact that this method was the anesthetic of choice in the late and bad risk patients. The mortality was higher in operations under a general than a spinal anesthesia. (Table IV.) Fallis also found this to be true in his review of 100 cases of perforations at the Henry Ford Hospital. He attributed the apparent superiority of spinal over general anesthesia to the fact that spinals were done during the latter years of his series and came into popularity during a period when gastric lavage, oxygen tents, etc., were employed with more regularity in the postoperative care of the patient.

TABLE IV
ANESTHESIA AND MORTALITY

Anesthesia	Recovered	Fatal	Mortality Per Cent
Spinal	42	7	14.2
Spinal-general	19	0	0.
General	47	11	18.9
Local-general	10	1	9.0
Local	9	3	25.0
Not recorded	1	1	
Total	128	23	

SITE OF PERFORATION

Over 90 per cent of all perforations in the duodenum occur in the first part just beyond the pylorus and usually in the anterior wall. (Table V.) Occasionally, the site involved is the superior surface and less frequently on the posterior wall. In this series, 128 perforations were in the duodenum and only nineteen in the stomach. Two were described as "pyloric" in location. One patient had two perforations, one in the first portion of the duodenum and the other on the anterior wall in the prepyloric region of the stomach. The mortality in the duodenal group was 14.8 per cent as compared with a death rate of 21 per cent in the gastric cases. McCreery, in reviewing 170 perforations at Bellevue Hospital, showed gastric to be twice as frequent as duodenal involvement. Sallick's figures in seventy-four cases also found the stomach more frequently the site of perforation. Williams and Walsh, on the other hand, recorded four times as many duodenal as gastric ruptures. None of the eleven female perforations were in the stomach.

TABLE V
SITE OF PERFORATION

Site	No. Cases	Fatalities	Mortality Per Cent
Duodenal	128	19	14.8
Pyloric (?)	2	1	50.0
Gastric	19	4	21.0
Duodenal and gastric	1	1	100.0
Not recorded	4	1	
Total	154	26	

BACTERIOLOGY

Marshall Davison and his colleagues have shown that the peritoneal culture usually is sterile during the first six hours and the convalescence in these patients is smooth. However, when the fluid from the abdomen contains organisms, the prognosis should be guarded. Clavels and Gellie have also made this observation in a series of cases in which 90 per cent of the patients with sterile cultures recovered and had no complications, while in the group with positive cultures, 50 per cent succumbed.

From 1923 to 1937, the peritoneal fluid was examined for organisms in only twelve cases and the findings were significant. In eight of these, the fluid was sterile and although one patient had delayed seventy-

two hours and three others did not come to operation until after six hours, all recovered. On the other hand, each of the four patients with positive cultures died. During the last three years, in twenty-eight perforations operated upon, cultures were taken in nineteen. Thirteen of these cultures were sterile and all the patients recovered. Of the six patients with positive findings in the fluid, three (50 per cent) died. For the entire series there were twenty-one sterile cultures with no fatalities and ten positive with seven (70 per cent) deaths. The offending organisms were staphylococcus, streptococcus, hemolytic and nonhemolytic, and Bacillus coli. (Table VI.)

Table VI
CULTURE OF THE PERITONEAL FLUID

Period	Sterile	Died	Non-sterile	Died	Mortality Per Cent
1923–1937	8	0	4	4	100.0
1938–1940	13	0	6	3	50.0
Total...	21	0	10	7	70.0

OPERATIVE PROCEDURE

Simple closure of the perforation was done in 143 patients. This method utilized either one or two purse-string sutures, or two rows of Lembert sutures or a combination of both a purse-string and several interrupted sutures. A small piece of adjacent omentum was tied over the closure. In two patients the method of closure advocated by Graham was employed. No attempt was made to close the perforation tightly, but three interrupted sutures were loosely tied over an omental patch placed over the perforation. Five patients, in addition to simple closure, had a gastroenterostomy performed at the same time. Two patients had pyloroplasty of the Heincke-Mikulicz type and one had an excision of the ulcer area and closure. All deaths in this series were in those closed by simple suture. Consideration, however, must be given to the fact that all late cases, and those considered to be bad risks, were treated in this manner. Gastric resection as a primary procedure was not performed in any case.

The choice of procedure has been a matter of much disagreement. Guthrie found that over 90 per cent of simple closures needed no further surgery and in every patient that died, autopsy revealed that neither a gastroenterostomy nor a partial gastrectomy would have reduced the mortality. McCreery believed that closure alone is a more satisfactory procedure than gastroenterostomy and closure, and in selected cases when necessary, a partial gastrectomy should follow.

Kerr, in a follow-up of his cases, found that 65 per cent were symptom free or almost entirely cured one to fourteen years after simple closure. Tondeur reported good results in 54 per cent of his patients. In another 30 per cent, a gastroenterostomy brought the satisfactory results to 84 per cent. White and Patterson record similar satisfaction with simple closure and conclude that partial gastrectomy as a primary operation is never justified. Consideration of a perforated peptic ulcer as an emergency requires immediate and rapid action. The operation of choice should be that which will help the patient through his immediate danger. The majority of British and American surgeons favor simple closure of the perforation. The procedure takes but a few minutes, is simple to do and does not require any unusual skill. Even those investigators who show poor results in 65 per cent of their cases and for that reason advocate more radical treatment must agree that in 35 per cent of the cases, unnecessary and meddlesome surgery will result.

DRAINAGE

There is no unanimity of opinion on the subject of drainage of the abdomen. Eliason and North state that drainage for a few days can do no harm. However, they are against prolonged drainage which is not necessary. They collected statistics on this

subject and divided the cases into three groups: First, those patients who were drained routinely; second, those who were drained frequently; and third, those who were drained only when in a late stage. They found the mortality highest in the first group, and least in the last, that is, in those who drained only in a late stage. Shawan in reviewing 389 perforations showed the present tendency to drain only the late ones. The policy at the Henry Ford Hospital, according to Fallis, is to drain all patients in whom there has been peritoneal soiling. The statistics from Bellevue Hospital reveal that drainage is rare. Much reliance is placed upon the proper and thorough cleansing of the abdomen and leaving the rest up to the ability of the peritoneum to take care of itself. Secondary abscesses are treated as they arise.

During the early years covered by this report, there were no basic rules followed for drainage. Sixteen patients coming to surgery within six hours were drained, while of those in whom the delay was at least twelve hours, twenty-one were drained and eighteen were not. During the last few years there has been less tendency to drain any patient and when it was done, it was only because gross contamination was present and the cases were in a late stage. (Table VII.)

TABLE VII
DRAINAGE

Time	Recovered		Fatal	
	Yes	No	Yes	No
1–6 hours	13	40	3	1
7–12 "	14	26	7	0
Over 12 hours	12	15	9	3
Total	39	82	19	4

OPERATIVE MORTALITY

There were 151 consecutive perforations of the acute type operated upon by thirty surgeons including the resident staff. Twenty-three cases were fatal, giving an operative mortality rate of 15.2 per cent. There were three patients admitted in extremis and they died without surgery six hours, eight hours and two days later, respectively. All were given expectant therapy and autopsy revealed the cause of death as acute purulent peritonitis due to the perforation of a peptic ulcer.

In the first eight years, seventy-six patients were seen with a mortality of 17.1 per cent. The death rate dropped in the last ten years to 13.3 per cent for an additional seventy-five cases. Eliason and Ebeling collected 1,940 cases in the United States with a mortality of 25.9 per cent, and an additional compilation of 3,121 perforations with a fatal rate of 22.6 per cent from the European clinics. They contributed seventy-four of their cases and showed a death rate of 47.2 per cent. Shawan offered 307 perforations of which 25 per cent were fatal. More favorable are the figures of Gilmour and Saint (4.7 per cent in sixty-four), Sallick (10.8 per cent in seventy-four), Graham (one death in fifty-one) and Southam (no deaths in thirty-four). The mortality rate generally is lower in the smaller series of cases one encounters in the statistical reports. In our series, only one death occurred in thirty-four consecutive perforations from 1930 to 1933, but as the cases accumulated there was a rise in the fatalities.

Graham attributes his excellent results to the alertness of the physician in making an early diagnosis and in bringing the patient to surgery without delay. Certainly the average time interval of only seven hours for all his cases indicates the speed which is so very essential in the treatment. Among Sallick's seventy-four patients were forty-nine perforations operated on within six hours with only one death. The average time interval for 151 perforations in this series was 13.1 hours.

Factors, aside from the perforation-operation time interval, over which the physician has very little control and which have some influence over the prognosis are

the age of the patient, the size of the perforation and the presence or absence of pyogenic organisms.

The mortality for all patients over forty years of age was 23.3 per cent as compared with the death rate of only 6.5 per cent in a similar number under forty years. (Table VIII, Fig. 3.)

TABLE VIII
AGE AND MORTALITY

Age	No. Cases	Died	Mortality Per Cent
Under 40 years.....	77	5	6.5
Over 40 years.....	77	18	23.3

The larger the perforation, the more rapidly will the gastroduodenal contents spill into the general peritoneal cavity causing a sudden severe and extensive contamination. In very small perforations, the leakage is slow and the contamination slight at the time symptoms develop. The mortality of 70 per cent in patients with a positive culture as compared with a recovery of 100 per cent in that group whose cultures were sterile is sufficient indication of the importance of this factor in the ultimate prognosis of the case.

SUMMARY

1. One hundred fifty-four consecutive acute perforated peptic ulcers were presented.

2. The male to female ratio was 13:1.

3. No female perforations were gastric.

4. Perforations are most frequent between the ages of twenty to sixty years.

5. A relative infrequency was noted during the warm months.

6. Eighty-four and four-tenth per cent had had some ulcer symptoms prior to operation.

7. Three patients had recurrent perforations; one had two simultaneous perforations, one duodenal and the other gastric. A second patient had two kissing duodenal ulcers, one perforated, the other bleeding. A third patient had both a perforated duodenal ulcer and an acute hydrops of the gallbladder.

8. Leucocytosis is the rule and is present early. When absent, the prognosis should be guarded.

9. Pneumoperitoneum was present in 80 per cent of the cases in which roentgen rays were taken.

10. Duodenal perforations were seven times as frequent as gastric, but the mortality was greater in stomach perforations.

11. Seventy per cent of those patients with positive cultures of the peritoneal fluid died.

12. One hundred forty-three perforations were closed by simple suture alone. Five had an added gastroenterostomy.

13. Drainage was employed only in late cases during the past few years.

14. The elapsed time interval is the important factor in determining the prognosis. The age of the patient, size of the perforation and the presence of pyogenic organisms in the peritoneal fluid also play a part.

15. There were twenty-three operative deaths in 151 perforations, or a mortality rate of 15.2 per cent.

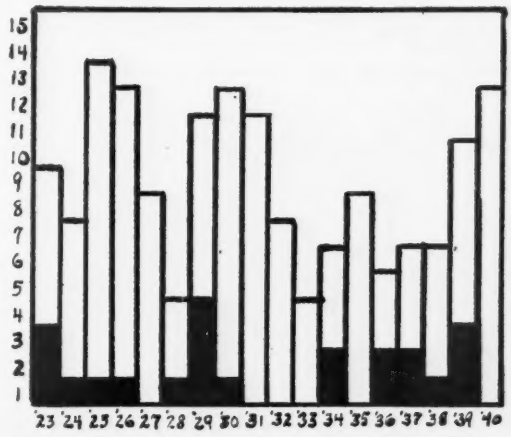

FIG. 3. Operative mortality 15.2 per cent. Heavy sections indicate fatalities—23; total number of cases 151.

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ENDOMETRIOSIS (ADENOMYOMA) IN POSTOPERATIVE SCARS

AN ANALYSIS OF THIRTY-ONE CASES*

ROLLIN G. WYRENS, M.D. AND LAWRENCE M. RANDALL, M.D.
Fellow in Surgery, Mayo Foundation — Section on Obstetrics and Gynecology, Mayo Clinic
ROCHESTER, MINNESOTA

ENDOMETRIOSIS was first recognized about fifty years ago, but only in the last twenty years has it received much attention. It now is considered to be one of the more important gynecologic conditions.

By endometriosis we mean the condition in which tissue resembling endometrium grows elsewhere than in the cavity of the uterus. In reviewing cases in which operations had been performed at the Mayo Clinic for this condition from 1923 to 1934, inclusive, Masson[8] listed the situations of such ectopic endometrium, in the order of decreasing frequency, as: uterus, ovary, pelvic peritoneum, fallopian tubes, rectovaginal septum, ligaments of the uterus, sigmoid flexure, vaginal wall, laparotomy scars, umbilicus, ileum, bladder and appendix. Other situations which have been reported in the literature include: inguinal lymph-nodes and the canal of Nuck, labia majora and minora, thigh, arm and, possibly, the lungs.

ETIOLOGIC ASPECTS

The etiology of endometriosis is unknown, although several theories as to causation exist. Probably the earliest of these explained the development of this condition from embryonic rests of remnants of the wolffian ducts or müllerian ducts. By some investigators the condition is considered to originate in the serosa of the peritoneum by a process of metaplasia, but other workers have said that it originates in the true endometrium and that it represents tissue growing from cells transported from the lining of the uterus. This migration is explained variously as metastasis through the blood and lymph channels, direct invasion or implantation. When the numerous situations of endometriosis are considered, it is difficult to explain the origin of this condition on the basis of one theory. Thus, direct invasion seems a feasible explanation for endometriosis of the uterus; a metastatic origin seems the only logical one for the disease as it occurs in the lungs; and metaplasia of the peritoneum, or implantation by means of retrograde menstruation can more logically explain the occurrence of the condition on the peritoneal covering of the pelvic or abdominal viscera than can other theories.

Authors have explained endometriosis found in laparotomy scars on the basis of one or the other of the preceding hypotheses. The majority of writers uphold the idea that this aberrant endometrium originates from true endometrial cells transplanted at the time of a surgical operation, or that direct invasion occurs from the exposed lining of the uterus or tubes or from misplaced endometrium that is present elsewhere in the abdominal cavity. The fact often is cited that endometriosis in laparotomy scars follows surgical operations on the uterus and tubes in the vast majority of cases. Hosoi and Meeker reviewed eighty-seven cases in which such an occurrence had been reported in the literature prior to 1929. In thirty-one cases endometriosis had followed ven-

* This series includes reports of cases previously published by Mahle and MacCarty, Lemon and Mahle, and Masson and Marble.

tral fixation operations on the uterus; in twenty-eight, salpingectomy, oophorectomy or both; in nineteen, cesarean section; in fifteen, appendectomy; in five, hysterectomy, and in the remainder, miscellaneous pelvic operations. Wespi and Kletzhändler reported seventy-three cases of "cicatricial endometriosis," in five of which the condition followed cesarean section and in sixty-eight of which it followed abdominal interruption of early pregnancy. Hertzler stated that when the endometrium has been exposed at the time of an abdominal operation, endometrioma of the abdominal wall subsequently will occur in from 1 to 2 per cent of cases.

the time of operation in four of these fifteen cases some type of intra-abdominal procedure was performed other than that which concerned the tubes or uterus, such as appendectomy and similar operations. In the four remaining cases of this group of fifteen the operation consisted solely of suspension of the uterus. In four of the total number of thirty-one cases the condition followed cesarean section; in four, salpingectomy; in two, hysterectomy; in two, myomectomy; in one, simple appendectomy; in one, drainage of an appendiceal abscess; in one, inguinal herniorrhaphy, and in one case the condition was listed as following some type of pelvic operation

TABLE I

ANTECEDENT OPERATION, SYMPTOMS, TREATMENT: THIRTY-ONE CASES OF ENDOMETRIOSIS IN POSTOPERATIVE SCARS

Antecedent Operation	Cases		Symptoms, Observations	No.	Treatment	Cases No.
	No.	Per Cent				
Uterine suspension	15	48.4	Pain or tenderness	26	Local excision only	7
Cesarean section	4	13	a. Only at menses	9	Local excision, irradiation	2
Salpingectomy	4	13	b. Continuous, worse at menses	14	Local excision plus other procedures to cure endometriosis	5
Hysterectomy	2	6.4	c. Not related to menses	3		
Myomectomy	2	6.4	Nodule	27	Local excision, other procedures unrelated to treatment of endometriosis	16
Drainage appendiceal abscess	1	3.2	a. Swelling at menses	5		
Appendectomy	1	3.2	Bleeding	4	Biopsy and irradiation	1
Inguinal herniorrhaphy	1	3.2	a. Only at menses	2		
"Pelvic operation"	1	3.2	b. Other times in cycle, but worse at menses	2	Total	31
Total	31	100.0	No symptoms; palpable nodule only	1		
			No symptoms; no palpable nodule	1		
			Nausea, vomiting at menses	1		

In the thirty-one instances of endometriosis in postoperative scars seen at the Mayo Clinic, and proved by pathologic study of the specimens, fifteen, or 48.4 per cent, had followed uterine suspension operations. (Table 1.) In seven of these fifteen cases some other procedure was performed on the uterus and tubes at the same operation, such as dilatation and curettage, salpingectomy and the like. At

performed elsewhere, the nature of which is not known.

In many of these procedures on the uterus and tubes, the linings of these organs are not exposed, but some adherents to the theory of the migratory origin of the condition explain that contamination of the edges of the abdominal wound is caused by the needle or suture inadvertently passing through their linings.

Nicholson[12] and others have upheld the theory that endometriosis originates in the peritoneum by a process of metaplasia to explain the occurrence of the lesion in postoperative scars, for the theories as to the origin of the condition by implantation or invasion do not satisfactorily explain all instances of the disease, and in particular, those that follow surgical operations on structures other than the uterus and tubes, and those in which the lining of the uterus or tubes is not exposed when the operation is performed. Such commentators contend that bits of peritoneum are caught in the wound, and that in this abnormal situation, metaplasia to endometrial tissue takes place. On the other hand, Sampson, explaining these cases on the basis that the condition is caused by the migration of endometrial cells, pointed out that manipulation of the tubes and uterus might cause slight soiling of the operative field, with endometrial tissue escaping by way of the ostia of the tubes. If this were true, endometriosis of the peritoneum would be expected to be associated in the majority of cases of endometriosis of postoperative scars. That it is not true is shown by the paucity of such observations in reported cases. Endometriosis of the peritoneum occurred only once in our series of cases.

To refute the theory that endometriosis arises by invasion, Nicholson[12] reviewed twenty-eight cases of the disease reported in the literature up to 1926, and stated that in none was there evidence that the tumor in the abdominal scar was continuous with the lining of the uterus. Two years later, however, Sampson demonstrated that the tissue of the tumor in the abdominal scar was continuous with the tissue of the lining of the uterus, in two cases, but in one other case no such connection was found. The latter, he explained as originating from contamination of the edges of the wound by transplantation of endometrial tissue.

In ten of our thirty-one cases the tumor of the abdominal wall was found to involve, or was adherent to, the uterus or tubes. Eight of these tumors involved the uterus alone; one was continuous with an endometrioma of the tube and one was continuous with an endometrioma which involved the uterus and round ligament. In all but four of these ten cases there was no evidence of connection with the lining of the uterus or tubes. In four cases a connection with the lining of these organs was strongly suggested, although not absolutely proved. In two of these cases the condition involved the uterus and followed salpingo-oophorectomy; in one case the condition followed uterine suspension, myomectomy and salpingo-oophorectomy on the right. In the other case the condition involved the left tube and followed an operation for uterine suspension.

INCIDENCE

Endometriosis occurring in a postoperative scar is a relatively rare condition. Since the disease was first described by Robert Meyer in 1903 there have been several reports of a single case or a few isolated cases. There also have been several analyses of cases previously reported in the literature, perhaps with the report of an additional case or two from the experience of the particular author concerned. Among 576 patients operated upon from 1923 to 1934, inclusive, for endometriosis, the condition having been proved as such by pathologists at the Mayo Clinic, Masson[8] found ten instances, or 1.77 per cent, of endometriosis in laparotomy scars. Fallas and Rosenblum reported that 0.83 per cent of 260 cases of endometriosis appeared in postoperative scars. From 450 to 500 cases of the condition were reported in the world literature up to 1941, but undoubtedly some of the cases were repeated. By far the largest single group of cases reported was that of Wespi and Kletzhändler, who reported seventy-three cases in which patients had been operated upon for the disease in one Zurich clinic in sixteen years.

We have been able to collect thirty-one cases of true endometriosis in postoperative scars from the records at the Mayo Clinic.

The patients were encountered from 1916 to 1941.

PATHOLOGIC ASPECTS

Endometriomas in laparotomy scars resemble endometriomas situated elsewhere

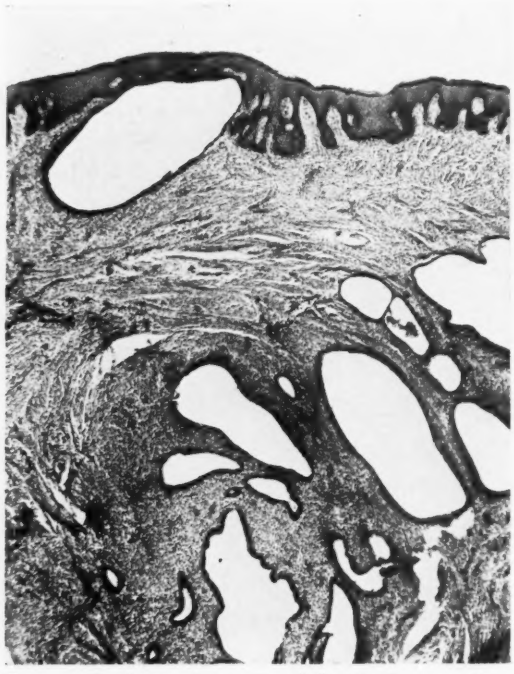

FIG. 1. Endometrioma in abdominal scar after cesarean section. Note the dilated uterine glands, the typical endometrial stroma, the close proximity to the skin and the invasiveness of the endometrial tissue (hematoxylin and eosin) × 25.

in the body in that they consist of a single layer of glandular epithelium similar to uterine lining and are frequently associated with endometrial stroma. (Fig. 1.) These glands and stroma undergo the proliferative, differentiative and menstruating stages which occur during the menstrual cycle of normally situated endometrium, as well as the decidual reaction which accompanies pregnancy. This aberrant tissue is invasive, follows the paths of least resistance and may be encountered branching and winding amongst the dense fibrous tissue of the scar. Occasionally, smooth muscle is encountered in association with the endometrial tissue, although none was found in our series of thirty-one cases.

Because these misplaced uterine glands frequently have no outlet for their secretions, cysts, filled with a mucoid or thin, fluid material, may be found, and not infrequently collections of old blood with hemosiderin may be encountered. (Fig. 2.) This results from breakdown and hemorrhage during the menses. Cellular débris, lymphocytes, large mononuclear cells and foreign-body giant cells frequently are observed.

In Meyers' case, a silkworm suture was found to be embedded in the center of the endometrioma, surrounded by cysts, tubules and cellular stroma. In one of our cases, in which hysterectomy had been performed elsewhere three years previously, the patient presented herself with a painful lower midline scar. On excision of the scar an endometrioma in which was embedded a silk suture was found in the lower margin. A case such as this one may be used by some investigators as evidence of transplantation of uterine epithelium by a contaminated suture, or invasion of the abdominal wall along the line of the suture. (This is evidence, it is true, but it is not conclusive evidence, for the two conditions may have been merely coincidentally present.)

The largest specimen in our series weighed 67 Gm. and was 10 by 6 by 3 cm. The smallest specimen was 1.5 cm. in diameter (Fig. 3), whereas the great majority of specimens were from 2 to 4 cm. in size and weighed from 5 to 15 Gm. In all cases except two a single tumor was present. In these two cases two nodules were present in each one. In one of these two cases endometriosis developed in a scar after drainage of an appendiceal abscess, and in the other case the condition occurred after an operation for uterine suspension had been performed. In the latter case a lower transverse incisional scar was found in each end of which was one nodule, joined in the midline by a thin strip of endometrial tissue.

"Cicatricial endometriosis," in which there is a sanguineous discharge, usually at the time of menstruation, must be distinguished from postoperative menstrual

fistula. Ballin stressed this fact and pointed out that a direct communication with the tubal or uterine cavity to the outside is present in the latter condition, whereas the former state represents a postoperative enclosure of endometrial tissue in the abdominal wall. It is possible that association of the two conditions might occur.

Fig. 2. Section of the endometrioma seen in Figure 1. Note the small, blood-filled cysts, and the lack of demarcation of the tumor.

Endometriomas may be situated anywhere throughout the thickness of the abdominal wall; they may be subcutaneous only, may involve the skin or peritoneum, and may be continuous with endometrial tissue in the abdominal cavity. As already stated, ten of our patients presented tumors in the scar which were continuous with an endometrioma situated in the uterus or tubes, or which were adherent to these structures. One patient presented a tumor that was adherent to the round ligament within the abdominal cavity. This tumor had developed after uncomplicated appendectomy. These cases may represent invasion of the abdominal wall by intra-abdominal endometrial tissue or invasion of the intra-abdominal structures from an endometrioma of the abdominal wall. In seven cases the condition was found to involve the round ligaments outside the abdominal cavity. In six of these cases the disease had followed operations for uterine suspension at which time the round ligaments had been placed outside the abdominal cavity. In one case the condition followed inguinal herniorrhaphy.

In several of our cases adhesions involving some intra-abdominal viscus were present, but there was no evidence that endometrial tissue was contained within these adhesions. In other cases the mass was limited to the skin, subcutaneous tissue, fascia or muscle or several of these layers, and adhesions did not exist. Removal in these cases was obtained by local excision with or without opening of the peritoneal cavity.

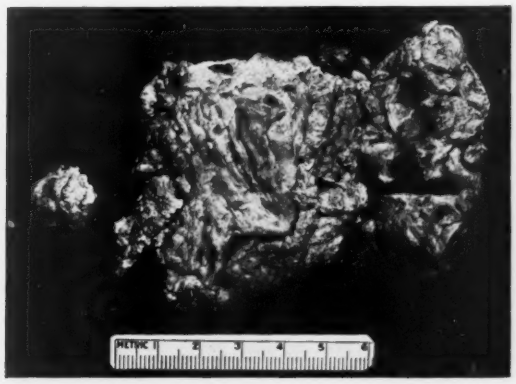

Fig. 3. Endometriomas removed from postoperative scars; the largest and smallest specimens removed from thirty-one patients.

CLINICAL SYMPTOMS AND OBSERVATIONS

Endometriosis in postoperative scars generally afflicts women of the third, fourth and fifth decades of life, during their active sexual lives, at an age when operation on the pelvic viscera is most frequently performed. Symptoms tend to appear a few months or years after the operation, and in a typical case a nodule appears in the scar, usually in the lower end, which becomes painful, and which may swell at the time of the menses. This nodule may become bluish, especially at the menstrual period, and may break down, discharging a sanguineous fluid. This is more likely to occur if the nodule is adjacent to, or involves, the skin.

In the cases reviewed by Hosoi and Meeker, the nodule appeared as late as twenty-six and a half years after the operation, and the lower end of the operative

scar was the site of predilection. Nicholson[11] reviewed cases reported in the literature, and found the interval between the operation and the onset of symptoms to vary from a few weeks to as long as twenty-one years, and he also stated that the tumors appear most frequently in the lower half of the operative scar. Wespi and Kletzhändler found that most patients presented symptoms within the first two years after operation, rarely immediately after, and on an average, 1.6 years after operation.

Some patients may present no symptoms or signs, except a nodule in the scar, as found by Heaney in his review of twenty-nine cases which had been reported in the literature. If symptoms occur, they usually are progressive in character.

Analysis of Cases. (Table 1.) In the thirty-one cases in which the patients were seen at the Mayo Clinic, the average age of the patients presenting themselves was thirty-six years; the youngest patient was twenty-three years old and the oldest was fifty years old.

Twenty-seven patients complained of symptoms produced by the endometrioma as their chief complaint. Three patients came to the clinic for reasons other than the condition under consideration, and the endometrioma in question was noted during the routine taking of the history or at the time of physical examination. In one case it was detected incidentally at the time of operation.

The symptoms of four patients began before or at the time the operative incision healed. The symptoms of nine patients started a year or less after operation. The longest interval after operation was twenty years, and followed drainage of an appendiceal abscess. The average interval between operation and the appearance of symptoms in twenty-eight cases was 4.2 years. In three cases the interval was not stated.

Pain or tenderness was experienced in the region of the incisional scar by twenty-six of thirty-one patients. Nine of these twenty-six patients had pain which was associated only with the menstrual periods; fourteen experienced pain throughout the menstrual cycle, but the pain was increased during the menses. In three cases the pain was unrelated to the menstrual cycle. Five patients stated that the abdominal discomfort started, or was intensified, just before the onset of the flow, while three patients experienced the onset or aggravation of pain immediately after cessation of the menstrual period. In the remaining fifteen cases, it was stated that the onset of the menses coincided with the onset or intensification of pain. Five patients did not complain of pain or tenderness.

Twenty-seven of our thirty-one patients presented a palpable nodule in the scar. Nodules were not found above the umbilicus, because all involved scars were situated in the hypogastrium, lower quadrants of the abdomen or inguinal regions. All but two of the scars were either vertical or oblique. Situation of the nodule in the scar was mentioned in nineteen cases. In thirteen cases the nodules were situated in the lower half of the scar, in four cases in the upper half of the scar, in one case in the center of the scar, and in one case the endometrioma extended the whole length of the scar. Five patients volunteered the information that the nodule swelled during menstrual periods. Among four patients nodules were not palpable.

Four patients experienced a bloody discharge from the region of the scar. For two patients this discharge occurred only during the menstrual period, but in two cases it was noticed at other times as well, although in these two cases it was more marked at the time of menstruation than at other times.

Three patients presented no symptoms, but all had palpable nodules in the scar. From one of these three patients the largest specimen of endometrioma in our series was obtained; it was 67 Gm. in weight. A patient additional to those mentioned previously had no symptoms referable to endometrioma, and the nodule was not detected, clinically, preoperatively.

Various menstrual irregularities were present in some of our cases, but they can all be explained on the basis of lesions other than endometriosis. One patient complained of nausea, vomiting, pain, swelling and redness of the lower portion of the abdomen during menstrual periods.

DIAGNOSIS

Simple Diagnosis. When the condition is typical, diagnosis should not be difficult. When a woman, from twenty to fifty years of age, presents herself with a history of a previous pelvic operation and relates that at some time after the operation she noticed a painful lump in the scar, which is more painful at the time of catamenia, the diagnosis usually is obvious. Among those patients who do not present symptoms, but only a palpable nodule, biopsy may be necessary before the diagnosis can be made.

Differential Diagnosis. Endometriomas presented as asymptomatic nodules may be mistaken clinically for keloids, desmoid tumors, fibromas, unabsorbed sutures or other foreign bodies. Patients who present only a painful scar often have been told that they have "adhesions," "neuroma," "painful scar" or that they are "just nervous." Painful nodules not associated with the menstrual period easily may be misdiagnosed as neuromas or incarcerated omental hernias. Endometriomas that discharge sanguineous fluid at the time of the menses may be distinguished from uterine or tubal fistulas by the injection of colored fluid through the fistula and observance of the cervix to determine whether or not this same fluid makes its appearance. Roentgenograms made after the injection of iodized oil may be useful in establishment of the diagnosis.

The diagnosis of adenomyoma or endometriosis of the abdominal scar was made clinically in fourteen (45.2 per cent) of our thirty-one cases. In the remaining seventeen cases the diagnosis was first made correctly at the time of operation by the surgeon or the pathologist. The majority of incorrect clinical diagnoses were reached prior to 1930, and relatively few thereafter; incorrect diagnoses were made probably because the entity has been more generally recognized in recent years than formerly.

TREATMENT

Prophylaxis. If the theory of implantation or invasion is correct, much may be accomplished to prevent the occurrence of this condition. Many surgeons advocate strict care in the performance of pelvic operations in which the endometrium is exposed. Gloves, towels and instruments should be changed before closure of the uterus or tubes, and care should be taken to touch the endometrium as little as possible and not to include the lining of the tube or uterus in sutures, whether the lining is exposed or not. Wespi and Kletzhändler stated that in their hands, with improved technic, the incidence of "cicatricial endometriosis" was decreased to a fourth of what it had been before the technic which they adopted was employed.

Active Treatment. Because endometriosis in postoperative scars seldom is associated with other types of intra-abdominal endometriosis, cure usually is easily obtained merely by excision of the nodule or scar. Such excision must be carried out carefully and widely, because the tumor is an infiltrating one and is not encapsulated. If any tissue remains, recurrence may be expected, as occurred in one of our cases. The patient in this case of recurrence had undergone cesarean section elsewhere seven years before she was seen at the Mayo Clinic. Two years after this operation she first noticed a lump in the incisional scar which swelled and became painful at the time of menstruation. This lump had been excised elsewhere at that time, and a "cyst" had been removed. The patient was relieved for a short time, but the same symptoms and signs reappeared. The nodule was widely excised at the Mayo Clinic and proved to be an endometrioma.

If another pelvic endometriotic process is present, whether or not it is continuous with the tumor in the abdominal scar,

other procedures probably will have to be carried out to obtain a cure. The endometrioma should be removed, whether removal requires hysterectomy or any other procedure, or, if it is too extensive the ovaries should be removed or irradiation therapy employed to reduce or obliterate ovarian function. The choice of these procedures depends on the technical difficulty that would be encountered, and the general condition and age of the patient.

In an analysis of our series of cases (Table 1), it is seen that cure was obtained in seven cases by means of local excision alone. In two cases, local excision was followed by irradiation therapy; and in five cases, a more extensive operative procedure was carried out to cure the endometriotic process which also was present in the abdominal cavity. In addition to removal of the scar tumor the following procedures were performed: subtotal abdominal hysterectomy and salpingo-oophorectomy on the right, hysterectomy and excision of a piece of omentum, salpingectomy on the left, salpingo-oophorectomy on the right, and, last salpingectomy on the left and excision of the left cornu of the uterus. In sixteen cases other unrelated operative procedures were performed, as well as local excision of the tumor. In one case it was technically impossible to remove the tumor, so excision of tissue for biopsy and postoperative irradiation were carried out.

SUMMARY

Thirty-one cases of endometriosis in postoperative scars were analyzed. It was found that in the majority of cases the lesion followed operations performed on the uterus or fallopian tubes, but that in the performance of most of these operations the lining of these organs had not been exposed. A few of the tumors seem to have originated from exposedp ortions of endometrium and to have invaded the abdominal wall secondarily, but others were definitely separated from the uterine lining.

The etiology of this condition is unknown, but, in most cases, the best evidence points toward transplantation or invasion (migration) of endometrium from the lining of the uterus.

The endometriomas in question resemble endometrium, histologically, and in one case an unabsorbed suture was presented, which may or may not represent the contaminating vehicle during the original operation. In a large number of cases in which the condition followed ventral suspension of the uterus, the round ligaments were involved with endometriosis, at those points at which they were sutured to the anterior abdominal wall.

Pain, worse at the menstrual period, and the presence of a palpable nodule, were most commonly complained of by the patients. Few of the tumors discharged a bloody fluid at the menstrual period. In a few cases there were no symptoms.

The diagnoses were made more often in the ten years prior to the time of this report, for the medical profession is now more aware of this entity than it had been formerly. The differential diagnosis most often includes, keloids, desmoids, fibromas, neuromas, incarcerated omental hernias and uterine or tubal fistulas.

If the condition is uncomplicated, cure may be obtained by wide excision. One instance of recurrence was encountered; undoubtedly the condition in this case was caused by inadequate excision at the time of the first operation.

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The absence of pigment in the skin is leukoderma, achromia or vitiligo. It may throw the normal skin into such relief that it may be mistaken as being pigmented.
From—"Symptoms in Diagnosis"—by Jonathan Campbell Meakins (Little, Brown and Company).

VAGINAL HYSTERECTOMY WITH PRYOR CLAMPS*

WALTER T. DANNREUTHER, M.D.
Professor of Clinical Gynecology, New York Post-Graduate Medical School and Hospital
NEW YORK, NEW YORK

IT may seem presumptuous to suggest the reconsideration of an old and largely forgotten operation for removal of the uterus, but the interest in its technic, displayed by certain members of the New York Obstetrical Society during recent months, seems to justify a brief plea for its retention in our surgical armamentarium. Most pelvic surgeons select supracervical, total abdominal, or vaginal hysterectomy as the operation of choice in an individual case in accordance with the indications, but comparatively few ever remove the uterus vaginally with clamps. Thirty years ago laparotomies were much more hazardous than they are now, and vaginal hysterectomy enjoyed greater popularity because of its relative safety. While many gynecologists are enthusiastic advocates of the vaginal technic, the majority of operators use sutures and seldom rely on clamps alone. Conceding that the clamp method has certain disadvantages, its merits should not be forgotten, as it distinctly minimizes the risk in elderly women, diabetic, and very obese patients, and those with a compromised myocardium or impaired metabolism. To Kennedy of Philadelphia should go the credit for maintaining a modicum of interest in a valuable procedure which might otherwise have become obsolete. Although the percentage of cases in which I have used clamps is relatively small, all of the patients were poor risks for any other type of operation, and none has died. The zero mortality may fairly be attributed to the fact that the operations were all done under low spinal or cyclopropane anesthesia given by an expert, in less than ten minutes. With the exception of one case in which it was necessary to remove an unsuspected ovarian cyst, and another in which there was little prolapse and a great deal of scar tissue, the hysterectomy averaged about six minutes.

TECHNIC

After deeply circumcising the vaginal vault and pushing the bladder upward to free it from the cervix, the peritoneum in the cul-de-sac is opened and widely stretched with the fingers, which brings the lower attachments of the broad ligaments into view. The corpus of the uterus is then delivered through the posterior vaginal vault with rake retractors. The uterus is grasped with the left hand, the middle finger being introduced between the broad ligaments and extended up to the uterovesical space. By incising the uterovesical fold of peritoneum over the finger tip, and stretching this opening laterally, the bladder and ureters are afforded perfect protection and the broad ligament attachments are again well defined. The finger serves as a guard in keeping the intestines out of the way, acts as a retractor on the uterus, and aids in the correct application of the clamps. Pryor hysterectomy clamps are applied from above downward to secure the broad ligaments on each side, and the uterus is cut away. The clamps are then inserted as high as possible in the pelvis, and plain gauze drains introduced between and up to the tips of the clamps. Iodoform gauze should never be used for this purpose. After removing the clamp handles, a Pezzer retention catheter is placed in the bladder and a tight T-binder is applied over a heavy gauze pad.

The gauze packing is removed after forty-eight hours. At the end of seventy-

* From the Department of Gynecology, New York Post-Graduate Medical School and Hospital, Columbia University. Read before the New York Obstetrical Society, November 11, 1941.

two hours the clamps* are gently unlocked and withdrawn, together with the retention catheter, under intravenous or light nitrous oxide anesthesia. The patient is kept in bed for twelve or fourteen days, during which period there may be a malodorous discharge, but no douches are given. Occasionally, there may be a little secondary vaginal bleeding between the eighth and twelfth day, which can be controlled by a hypodermic injection of morphine, and elevation of the foot of the bed. Re-packing the vagina is unnecessary. Kennedy and some other operators advise performing whatever plastic vaginal operations are needed on the eighteenth postoperative day. Personally, I prefer to defer such procedures for three or four months, because they would still further protract a long hospital confinement and I have found that the patients are in much better physical condition if given a reasonable interval to re-establish their circulatory activity. In fact, the marked improvement in the general condition of many of these women, particularly those who have been relieved of a distressing prolapse, is striking.

The disadvantages of a clamp vaginal hysterectomy are the undesirability of attempting the operation unless the uterus is movable, the transitory but unpleasant vaginal discharge, the possibility of late slight postoperative bleeding, the unusually long period of hospitalization, the preclusion of doing coincidental plastic operations and the necessity for special instruments. On the other hand, the rapidity with which the operation can be completed, the conservation of the patient's vital resistance, the complete absence of shock, the safeguarding of the bladder and ureters, the freedom from postoperative complications and the smooth convalescence make it a valuable asset for substandard risks.

*These clamps are now made in the United States by the George P. Pilling & Son Company, Philadelphia.

ACUTE PERFORATED PEPTIC ULCER SYNDROME WITH SURGICAL MANAGEMENT

REPORT OF 124 SURGICAL CASES

DAN C. DONALD, M.D. AND S. J. BARKETT,* M.D.
Surgical Staffs, Baptist and Hillman Hospitals — Surgical Resident, Baptist Hospital
BIRMINGHAM, ALABAMA

THE mortality rate in perforated peptic ulcer shows a wide variation. Eliason and Thigpen, reporting from a series of seventy cases, including both duodenal and gastric ulcers, give a mortality rate of 21.43 per cent.[1] H. L. Thompson, reporting a series of 500 cases, gives a gross mortality of 40 per cent.[2] R. R. Graham, reporting fifty-one cases, finds a rate of 1.8 per cent.[3] The reports from other writers show similar variations in the death rate of this disease. The mortality rate is lowest in the smaller selected group of cases. In the larger groups from urban hospitals the rate is higher, due to the delay of the patient in reaching surgery after perforation occurs, and to low physical reserve.

During the past several years the bulk of the literature on perforated ulcers has been concerned with the importance of the interval from perforation until operation and the efficacy of the simple closure. It is a recognized axiom that the sooner perforated peptic ulcers are operated upon the better the prognosis, and the consensus has been that simple closure incorporating the omental graft is the operation of choice. It is our purpose to stress, also, the importance of the etiological factors concerned in the location of this lesion and its perforating character and the surgical management in its relation to the late results following recovery in certain selected cases.

Our report based on a study of 124 cases of perforated ulcer (all except eight patients were operated upon and those eight were confirmed at autopsy) corroborates previous studies that the time element is the most important factor in the mortality of this complication. Age, sex and color are important etiological factors in that 70 per cent of these cases occurred from the third through the fifth decade, 93 per cent occurred in the male, and 82 per cent occurred in the white race. The location of the ulcer was in the duodenum in 88 per cent of the cases, in the stomach in 10 per cent, and in the gastrojejunal stoma following gastroenterostomy in 2 per cent. Forty-five and eight-tenths per cent of all the cases were drained and the remainder were not. In this total of 124 cases there was an operative mortality rate of 18.5 per cent. Of this total, forty were personal cases, nineteen of which were private cases and twenty-one from Hillman (Charity) Hospital, while sixty-eight were from the general staff of Hillman Hospital from 1936 to 1940 and twenty-six from the general staff of the Baptist Hospital. The foregoing facts are summarized in the following table:

Location	Per Cent	Sex	Per Cent	Color	Per Cent	Age	Per Cent
Duodenum	88	Male	93	White	82	30 to 60 years	70
Stomach	10	Female	7	Colored	18		
Gastrojejunal stoma	2						

* Dr. Barkett is now First Lieutenant, U. S. Army Medical Corps, Scott Field, Illinois.

The total number of deaths in this series of 124 cases was thirty-one. Eight of the patients were not operated upon and are not considered in calculating the operative mortality of 18.5 per cent. These cases may be divided into three groups: (1) the eight patients who were not operated upon; (2) those who were operated upon within twelve hours after perforation; (3) those who were not operated upon until more than twelve hours after perforation. An analysis of the group of eight patients not operated upon reveals that none sought admission until two or more days following perforation, and, due to their general condition and widespread infection, surgery was deemed inadvisable. In the second group, those operated upon within twelve hours, there were seven deaths. Of these, one had multiple duodenal ulcers and died of general peritonitis. In one the ulcer was not found and autopsy revealed jejunal ulcer with general peritonitis. The other five died of an overwhelming infection with general peritonitis.

An analysis of the seven deaths in the second group is of interest because as far as the time element is concerned the patients were operated upon soon enough, yet they expired:

Case No.	Age	Color	Sex	Duration of Perforation—Hours	Results
1	42	W	M	5	Multiple duodenal ulcers, drained, died of general peritonitis; ulcer closed
2	40	C	M	6½	Duodenal ulcer, simple closure with omental graft; died 7 days later; general peritonitis
3	46	W	M	12	Ulcer not found; autopsy revealed ruptured jejunal ulcer with general peritonitis
4	40	W	M	6	Duodenal ulcer, closed; drained; died 7 days later of general peritonitis
5	44	C	M	3	Gastric ulcer; excised; drained; died 7 days later of general peritonitis
6	56	C	M	11	Duodenal ulcer, closed with purse string; died 1 day following operation; general peritonitis
7	78	W	M	3	Duodenal ulcer; lived 4 days; died of general peritonitis

In the group not operated upon until more than twelve hours after perforation there were sixteen cases, all of which had been perforated for at least twenty-seven hours. In our total of thirty-one deaths out of the entire series of 124 cases, there were no patients who had been operated upon between twelve and twenty-seven hours after perforation. In this last group all died of general peritonitis with various complications, such as pleurisy, lung abscess and wound infections. Of this entire group of twenty-three operative deaths, only two patients had pyloroplasties, seventeen had simple closures, two had gastric resections and two had gastroenterostomies, in addition to simple closure. (Fig. 1.)

DISCUSSION

In the discussion of peptic ulcer we wish to emphasize the relationship between its location and pathological features and its perforating character. The first or suprapapillary portion of the duodenum is the site of perforated peptic ulcers nine times as often as the stomach. This is due in part to the ischemia of its mucous membrane and the corrosive action of the acid gastric juice. Here when irritation is present healing occurs more slowly.

When an ordinary portion of the stomach mucosa is injured there is a production of mucin which serves as a protector and healing readily occurs. On the Magenstrasse, where the majority of gastric ulcers occur and where the mucous membrane is tightly stretched and no mucin is produced, healing occurs with difficulty. Perforated ulcers are occasionally seen here, but it is not the usual antecedent complication, since 70 per cent of the ulcers in this location, especially those occurring in proximity to the pylorus, undergo malignant changes. Furthermore, as contrasted to the anterior surface or the suprapapillary portion of the duodenum, the stomach being in close apposition in the rear to the posterior peritoneal covering the peritoneal cavity will not likely become flooded from the spill of the ulcer.

Thrombosis of the blood vessels of stomach or bowel occurring independently

or in combination with infected emboli from oral sepsis is responsible for a high percentage of peptic ulcers. A survey of the personal cases revealed that 80 per cent have graded infections of the mouth ranging from a moderate degree of gum irritation to advanced pyorrhea alveolaris.

Heritage or family predisposition for peptic ulcer development may hold true in the perforated type of ulcer as in many other diseases. We found some indications that when one member of a family is affected with perforated peptic ulcer, all members of the same family affected with peptic ulcers will have symptoms of the perforative type or may go to actual perforation. Such an incidence was found in the group of personal cases. Two brothers had acute perforated duodenal ulcers. Records show the perforations were eighteen months apart. Both were operated upon within six to eight hours after inception of perforation, with recovery. We are informed that a third brother succumbed to operation for perforated peptic ulcer three years later. This is interesting evidence, but, of course, not conclusive.

The majority of acute peptic ulcers heal quickly and completely. From the clinical and *x*-ray evidence it appears that an ulcer may heal, recur, break down and heal again, the ulcer becoming deeper and more fibrotic with each recurrence. We believe, and such opinion is based on a careful study of the peptic ulcer problem, that once peptic ulcer attains the behavior of a perforating ulcer it will remain such during its period of existence. Healing of such ulcer is interfered with in the following ways: (1) the irritative effect of the acid gastric juice; (2) the necrotic layer on the base of the ulcer which covers the granulating tissue and provides no footing for the ingrowing epithelium, and (3) the dense scar tissue which prevents the approximation of the edges.

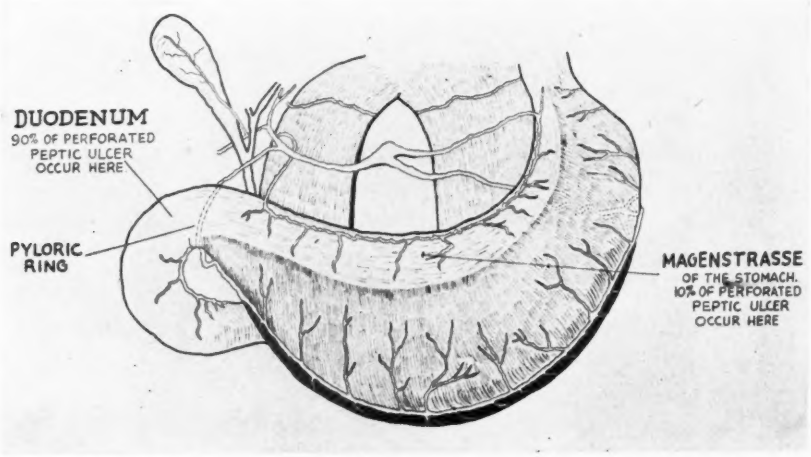

FIG. 1. Diagram of stomach and first portion of duodenum with circulation.

SYMPTOMS

The symptoms of acute perforation, as so aptly set forth by Graham,[4] are (1) the upper abdominal rigidity, (2) pain in this area associated with tenderness, and (3) inability to turn from side to side in bed because of accentuation of pain.

In this subacute type of perforation the pain is not as a rule as excruciating nor is the prostration as profound as in that associated with acute perforation. Early examination reveals, however, the same board-like rigidity and marked upper abdominal tenderness. Within two to ten hours after the perforation has occurred the symptoms may have subsided and the patient may be fairly comfortable. If the patient is seen for the first time in this quiescent period, and especially if an opiate has been administered, the presence of the abdominal catastrophe may not be

suspected. The degree of local peritoneal irritation and disability is dependent upon the amount of gastric and duodenal content that has escaped. Local peritonitis and subphrenic and perigastric abscesses are not uncommon. They may be the origin of many cryptogenic, hepatic and subphrenic abscesses and external perigastric adhesions. Those cases in which the ulcer heals cause no further trouble and leave little, if any, evidence of the former existence of ulcers.

Chronic perforation occurs in 25 per cent of the cases of chronic peptic ulcer, and in 3.5 per cent of gastric carcinomas that are surgically verified. If the pain is of a continued boring nature, if the usual mode of obtaining relief is ineffectual, if the so-called pain-food-ease sequence is less distinctive, and especially if the originally localized pain extends toward the region of the liver posteriorly, or upward into the chest—or in the case of the jejunal ulcer downward toward the pelvis—the possible presence of a deep penetration or slow perforation should be seriously considered.

DIAGNOSIS

Other abdominal catastrophes which must be considered in any differential diagnosis of perforated ulcer are acute hemorrhagic pancreatitis, gallbladder disease, appendicitis, ruptured ectopic pregnancy, volvulus of stomach or omentum and abdominal crisis in tabes. Extra-abdominal lesions which must be considered are pleurodynia, lobar pneumonia, measles, arachnodism, herpes Zoster and coronary occlusion. The presence of the associated signs characteristic of these conditions plus a careful history usually establishes the diagnosis.

TREATMENT

The treatment is essentially surgical with operation as soon after perforation as possible. A prime consideration, we believe, based on personal experience, is that an opiate should be withheld until diagnosis has been definitely made and surgery scheduled. We recall a specific case in which there was an associated heart condition to which an opiate was administered. The symptoms were masked so that the patient was judged improved, sent home five days after admission to the hospital, and expired there on or about the tenth day. Autopsy revealed a perforated gastric ulcer with generalized peritonitis, left subphrenic abscess, left pelvic abscess and moderate spill along the left colon gutter. Furthermore, disturbing diagnostic procedures such as fluoroscopy should be avoided, for they not only consume time, but aggravate an abdomen which should be kept at rest. We do favor, however, a flat *x*-ray plate of the abdomen immediately on admission to the hospital, with the patient in standing or sitting posture, for possible detection of air under the diaphragm, which is considered pathognomonic of a perforated viscus in these cases.

Preoperatively, intravenous fluids should be administered to combat dehydration and impending shock. Nothing, of course, should be given by mouth. If immediate operation has been decided on, a hypodermic or morphine gr. $\frac{1}{4}$ and atrophine gr. $\frac{1}{100}$ should be given.

ACUTE PERFORATED DUODENAL ULCER

Acute perforated peptic ulcer occurs in the duodenum in 90 per cent of the cases. (Fig. 2.) The simple closure of the ulcer with interrupted sutures, incorporating a fold or graft of omental tissue, is the operation most often employed. There are certain essentials in this type of closure that should be stressed to obviate leakage and maintain the proper circulation in the involved tissues. The sutures are placed in the bowel wall a sufficient distance from the ulcer-bearing tissue to assure security of the suture. In the approximation of the omental tissue to the ulcer bed in tying the sutures only sufficient tension should be made to hold the graft in place. Avoid constriction of the tissues that may interfere with their viability. The fibrin deposit as a result of the contact of the tissues will

seal the ulcer. In the hands of the average operator, this type of closure will maintain the lowest operative mortality. Many of

began to alter our simple closure to pyloroplasty in a certain selected group of cases. As a result of this type of therapy our

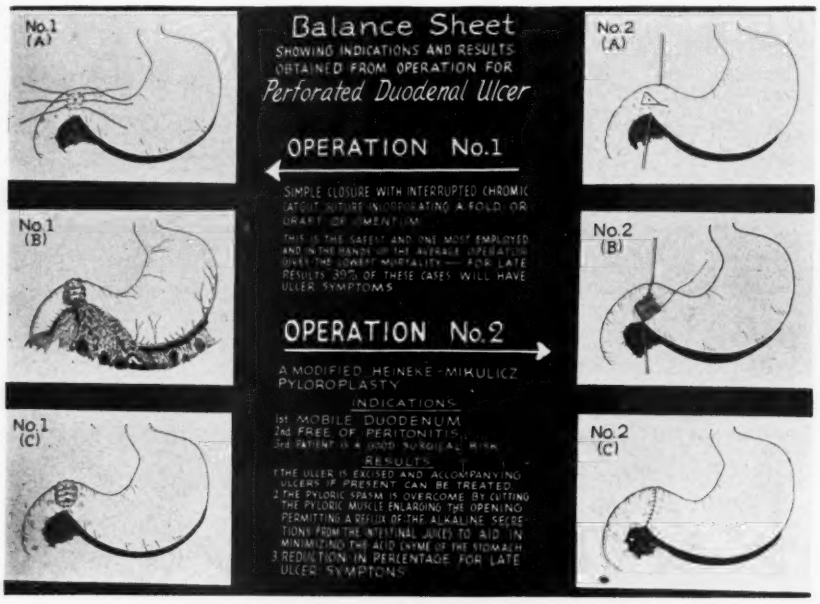
No.1 (A)
Balance Sheet
SHOWING INDICATIONS AND RESULTS OBTAINED FROM OPERATION FOR
Perforated Duodenal Ulcer
No.2 (A)
OPERATION No.1
SIMPLE CLOSURE WITH INTERRUPTED CHROMIC CATGUT SUTURE INCORPORATING A FOLD OR GRAFT OF OMENTUM
THIS IS THE SAFEST AND ONE MOST EMPLOYED AND IN THE HANDS OF THE AVERAGE OPERATOR GIVES THE LOWEST MORTALITY — FOR LATE RESULTS 39% OF THESE CASES WILL HAVE ULCER SYMPTOMS
No.1 (B)
No.2 (B)
OPERATION No.2
A MODIFIED HEINEKE-MIKULICZ PYLOROPLASTY
INDICATIONS
1st MOBILE DUODENUM
2nd FREE OF PERITONITIS
3rd PATIENT IS A GOOD SURGICAL RISK
RESULTS
1 THE ULCER IS EXCISED AND ACCOMPANYING ULCERS IF PRESENT CAN BE TREATED
2 THE PYLORIC SPASM IS OVERCOME BY CUTTING THE PYLORIC MUSCLE ENLARGING THE OPENING PERMITTING A REFLUX OF THE ALKALINE SECRETIONS FROM THE INTESTINAL JUICES TO AID IN MINIMIZING THE ACID ENZYME OF THE STOMACH
3 REDUCTION IN PERCENTAGE FOR LATE ULCER SYMPTOMS
No.1 (C)
No.2 (C)

FIG. 2. Type of operations for perforated duodenal ulcer.

the writers in dealing with the perforated duodenal ulcer stress the simple closure for the reason that acute perforation is an emergency problem and anything beyond closure of the ulcer is meddlesome surgery.

Statistics show approximately 39 per cent of the patients who have had simple closure continue to have ulcer symptoms. Aside from the delayed digestive complaints a small percentage of the duodenal ulcers treated in this manner will reperforate. During a five-year period Graham[5] reported fifty-one cases of acute perforated duodenal ulcer in which the patients were operated upon by the simple closure with omental graft. Of these, 11 patients or 21+ per cent continued to have digestive complaints, requiring elective surgery in the form of gastric resection, pyloroplasty or gastroenterostomy.

For a number of years we employed the simple closure incorporating omental tissue exclusively with practically the same results. After due consideration through close observation relative to reperforation and the high percentage of patients who continued to have digestive complaints, we mortality has remained as low or lower than that observed from simple closure. The delayed digestive complaints have been reduced to less than 10 per cent with reduction in number of reperforations. We have found pyloroplasty offers the maximum results in the cases which reveal the following characteristics: (a) the duodenum is mobile; (b) peritonitis is not present; (c) patient is a good surgical risk; (d) induration at ulcer area is such that removal of the ulcer will not sacrifice so much tissue as to interfere with proper closure of opening in bowel and stomach.

By pyloroplasty an ulcer is excised and oftentimes an accompanying ulcer may be found on the opposite side of bowel, commonly called "contact or kissing ulcer," which can be treated by cautery. The spasm of the pylorus is overcome by cutting the pyloric muscle; the ulcer is excised in a combined rectangular-elliptical incision going well on to the stomach; the closure of opening in the bowel and stomach is in a transverse manner. (This is a modification of the Heineke-Mikulicz pyloroplasty.) As a result of such closure the

pyloric opening is enlarged, permitting a free reflux of the alkaline secretions from the bile, pancreatic and intestinal juices on the stomach mucosa to reduce the acidity of the chyme.

Posterior gastroenterostomy at the time of closure of ulcer should be avoided for two reasons: (1) The edema present at the pyloric ring at the time of perforation in the majority of cases rapidly subsides following closure of the ulcer sufficiently to secure free drainage of the stomach; (2) the gastric juice in perforated ulcer usually shows a higher percentage of free hydrochloric acid than is normally present. This hyperchlorhydria with its constant bathing of the new stoma frequently leads to the formation of marginal jejunal ulcer. However, in definite obstruction of the pylorus resulting from the duodenal ulcer with perforation, or in the chronic perforated ulcer, posterior gastrojejunostomy may be indicated.

ACUTE PERFORATED ULCER IN THE STOMACH

In our series of cases 10 per cent of the perforations occurred in the stomach. The relationship of the ulcer formation in the stomach to the Magenstrasse area and the tendency for such ulcers in proximity to the pylorus to undergo malignant changes has been discussed.

The surgical management of the perforated ulcer occurring on the anterior wall of the stomach is usually accomplished by a simple closure with an omental graft. Should the ulcer present evidence of malignancy, biopsy should be made at the time of closure.

Perforated ulcers on the posterior wall of the stomach behave differently from those seen on the anterior wall. Normally, the posterior wall of the stomach is in close proximity to the pancreas and posterior peritoneum.

When the ulcer becomes inflamed or perforated, protective adhesions are formed at the ulcer bed. In a certain percentage of these cases the formation of the adhesions will prevent a spill of the stomach content into the peritoneal cavity.

Due to the localization of the infection the ulcer often acquires the characteristics of a subacute ulcer.

In case the ulcer is near the lesser curvature of the stomach and lacks the protection of adhesions, or when the crater of the ulcer is of such size that the adhesions do not prevent the spill following perforation, peritonitis results. The surgical repair for the perforated ulcer on the posterior wall of the stomach is rendered difficult and closure is seldom attempted due to the position, inflammatory adhesions and inability to secure good closure of the ulcer. Management demands some form of gastric resection, depending on the condition of the patient, and the inflammatory changes that have taken place about the ulcer. If the case is one in which the general condition of the patient is good and the adhesions and inflammatory changes are not extensive, a one-stage resection of the stomach with a posterior gastrojejunostomy by the Polyá II type operation or Hofmeister subtotal gastrectomy with gastrojejunal anastomosis will be indicated.

Should the patient show evidence of toxemia and low reserve, accompanied by dense adhesions at the point of perforation and evidence of a recent spill, a two-stage resection with a posterior gastrojejunostomy should be done, as advocated by Devine.[6] At the first-stage operation the stomach should be bisected proximal to the ulcer bed, leaving sufficient tissue on the blind end of the stomach to secure a good closure. After closing the lower end of the stomach where the ulcer is located, the proximal resected end should be closed from the lesser curvature down to a point leaving sufficient opening to make an adequate gastrojejunal stoma by an end-to-side posterior gastrojejunostomy. If the spill of the ulcer bed is sufficient to encourage peritonitis, a penrose drain should be placed down to the ulcer bed. At a subsequent date when the patient's condition will permit—and this will usually

require two to three weeks—the blind end of the stomach containing the ulcer is removed, including the pylorus with closure of the duodenal stump.

REPORT OF CASE TO ILLUSTRATE EFFICACY OF THE TWO-STAGE RESECTION

A white male, fifty-six years of age, entered the hospital on April 11, 1941. He gave a history of stomach trouble for several years. In February, 1941, the so-called food-ease sequence was replaced by a progressive boring pain in the left upper abdomen, aggravated by taking food, accompanied by nausea and vomiting, with loss of eighteen pounds in weight in two months. A large fixed mass was found in the left upper abdomen. Urine examination was negative. Blood picture was that of secondary anemia. The white blood count was 16,700 cells per cm. of blood with 80 per cent neutrophiles; the remainder of white cells were normal. Gastric analysis was 24 free hydrochloric acid and 42 total acids.

X-ray of stomach showed 33⅓ per cent retention of the six-hour barium meal and defect in midportion of stomach. Operation on April 19, 1941, was performed with spinal anesthesia. The abdomen was explored through an upper rectus incision, which disclosed a large inflammatory tumor, measuring 10 by 12 cm. in diameter at the base. Incorporated in the tumor mass were stomach, pancreas and posterior peritoneal wall, caused by perforated ulcer on the posterior wall of the stomach. Along the lower margin of mass peritonitis was present, resulting from spill of the ulcer. Obviously a subtotal resection of the stomach was indicated. Due to the inflammatory changes and recent spill from the ulcer, a two-stage antral exclusion resection of the stomach with a retrocolic end-to-side gastrojejunoscopy by the Polyá II type operation with closure of the blind end of the stomach was done. A penrose drain was placed at the point of perforation of the ulcer to care for the peritonitis.

The convalescence was a smooth one. The patient left the hospital in two weeks, to return two weeks later for the second operation, when the blind end of the stomach including the pylorus was removed with closure of the duodenal stump and peritonealization of the raw tissues at the bed of the stomach. Convalescence was again uninterrupted. By the multiple-stage operation the patient was carried through surgery with a minimum shock and the elimination of the technical difficulties and complications.

JEJUNAL ULCER PERFORATION

There were two cases of jejunal ulcer in our series. Of these two, one patient went to surgery and the ulcer was not found until autopsy. The other patient was not operated upon, as he was in extremis when admitted to the hospital and died the next day. Autopsy revealed perforated ulcer with peritonitis. Jejunal ulcers occur on the efferent loop of the bowel and the majority are perforating in character. History of return of digestive complaints, after apparent cure of duodenal or gastric ulcer following gastroenterostomy, pain in the left abdomen, not relieved by taking food and appearance of melena stools indicate a jejunal ulcer. Treatment resolves into excision of the stoma, closing the opening in jejunum in transverse manner, or a resection of the loop bowel with end-to-end anastomosis if the ulcer crater involves too much of the bowel wall. The opening in the stomach should be closed to allow the stomach to drain by the duodenal route provided the pylorus is patulous and the duodenal ulcer is healed. If obstruction of the pylorus is found or activation of the ulcer is present, partial resection of the stomach by the Billroth I type operation gives the best results.

Drainage should be done only in those cases of perforated peptic ulcer in which definite peritonitis is present or several hours have elapsed before surgery and there is unusual amount of spill of undigested food from the perforated viscus. In the case in which intraperitoneal drainage has not been provided, to avoid wound infection, place a rubber tissue drain down to the peritoneum, especially in the obese type individual; this will reduce the number of abdominal wall infections.

We believe spinal anesthesia for the patient with a perforated peptic ulcer gives the best results, affording a better relaxa-

tion of the abdominal wall and the peritoneal tissues, thus giving an opportunity for ample exposure. This tends to minimize the time of operation and also reduces the postoperative chest complications which are frequently seen in inhalation anesthesia in upper abdominal surgery.

CONCLUSION

From the analysis of this series of cases the following conclusions were drawn:

1. Ninety per cent of the perforated peptic ulcers are located within 2 cm. of the pylorus on the anterior surface of the duodenum.

2. Duodenal ulcers tend to perforate in this area because of the poor blood supply, constant bathing of the ulcer with acid gastric juice and lack of any anterior protective covering.

3. On the basis of late results following simple closure with omental graft this type of operative therapy might be altered to a pyloroplasty when the time interval of perforation has been only a few hours, provided peritonitis is absent, the duodenum is mobile and the patient is a good surgical risk.

4. Posterior gastrojejunostomy should be done only in the obstructive or chronic perforative and not in the acute perforated type.

5. By surgical intervention as soon as possible our mortality has been decreased to 18.5 per cent in the 116 operative cases in this total series of 124 cases.

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CARCINOMA OF BODY AND TAIL OF PANCREAS*

A CLINICAL AND PATHOLOGICAL ENTITY

B. CARL RUSSUM, M.D.
Professor of Pathology and Bacteriology,
Creighton University School of Medicine

AND

OSCAR CARP, M.D.
First Lieut., M.C., Fort Robinson,
Little Rock, Arkansas

OMAHA, NEBRASKA

ACCUMULATING reports in medical literature, as well as our observations upon twenty-six instances of pancreatic carcinoma encountered in 3,500 autopsies, have impressed us with the importance of carcinoma of the body and tail of the pancreas. We believe that malignancy in the body and tail deserves greater consideration than is usually given in the differential diagnosis of pancreatic malignancy. Such consideration is merited because of the frequency, the suggestive clinical picture and the fact that the pathological condition differs from that of lesions in the head of the organ.

FREQUENCY

The frequency of carcinoma of the body and the tail of the pancreas is not appreciated. Bard and Pic's[1] description in 1888 of the clinical syndrome of carcinoma of the head is familiar, but it is not generally realized that carcinoma of the body and tail is about one-third as frequent. Duff[2] recently compiled 1,108 cases of pancreatic carcinoma from the literature and added fifty cases encountered in the first 14,000 autopsies at Johns Hopkins. In the series 596 were in the head, 166 in the body or tail or both, 186 in the whole pancreas, while 230 were in undetermined or unrecorded locations. Duff was able to study the clinical and pathological records of sixteen examples of the body and tail. Ransom,[3] at Ann Arbor in 1935, studied sixteen similar cases.

Lack of interest or appreciation of carcinoma of the body and tail as an entity to be distinguished from carcinoma of the head is reflected in medical literature. During the years 1931 to 1940 inclusive 163 articles on carcinoma of the pancreas are listed in the Index Medicus. In this number 111 discuss simply carcinoma of the pancreas, thirty-three carcinoma of the head, while only seven are concerned with cancer of the body and six deal with cancer of the body and tail and cancer of the body and tail.

Medical and surgical texts commonly have emphasized carcinoma of the head of the pancreas when discussing malignancy of this organ. Lesions of the body and tail have been treated as rare or unimportant. Usually the statement is made that carcinoma of the head is the most frequent lesion and then the symptoms of that lesion are elaborated.

In the 1933 edition[4] of a widely used Textbook of Medicine, and again in the 1940 edition,[5] we read "carcinoma usually occurs in the head of the organ and rapidly involves the bile-duct and adjacent lymph nodes. . . . The symptoms vary with the location of the tumor, but great weakness, loss of weight, and extreme anorexia are always present. . . . The pain and tenderness vary with the amount of involvement of the celiac plexus. The pain is characteristically of a severe, boring or grinding type and extends through to the back." No attempt is made to point out the clinical picture characteristic of carcinoma of the body or tail.

In the 1936 and 1939 editions[6,7] of a widely used Textbook of Surgery we find: "primary carcinoma of the head of the pancreas is by far the most frequent. . . . The symptoms of cancer of the pancreas

* From the Department of Pathology, The Creighton University School of Medicine, Omaha, Nebraska.

are dependent on compression of nerves, blood vessels and bile ducts and on the interference with the digestive function. . . . Jaundice appears early because of the fact that the common duct which passes through or beneath the head of the pancreas, is so easily compressed. . . . It is usually the first symptom which sends the patient to his physician. Pain is a symptom of importance and is usually colicky at first. . . . Later it becomes dull and constant and is referred to the back." The symptoms—jaundice and pain—and tumor and *x*-ray findings are discussed, but no distinct clinical picture of cancer of the body and tail is presented.

In the differential diagnosis chronic pancreatitis is considered of great importance, but no effort is made to differentiate the site of any existing carcinoma.

As a result of this emphasis upon carcinoma of the head, most students and practitioners think that the lesion occurs almost exclusively in that region. We have repeatedly questioned senior students about cancer of the pancreas and invariably they describe the clinical syndrome indicating involvement of the head.

It would seem that the frequency of cancer of the body and tail, one-third that of cancer of the head, would entitle it to more emphasis in teaching and medical writing. If it is possible to distinguish between the two, the methods for so doing should be taught.

CLINICAL CHARACTERISTICS

That carcinoma of the body and tail does present a suggestive clinical picture has been well established. It was first pointed out in 1908 by Chauffard[8] who reported three cases with severe pain, rapid and severe emaciation and absence of jaundice. The pain was epigastric, sudden in onset, beginning on the left but soon generalizing over the abdomen and radiating to the back, chest or scapulae, and unrelated to food. The pain resembled that of tabetic crises, while nausea and vomiting were unimportant. Chauffard's observations did not evoke a great deal of interest, nor did subsequent contributions by Leriche[9] and Malus.[10] Two excellent recent articles, by Ransom[3] and Duff,[2] deal with the subject.

Ransom's studies confirmed the clinical picture originally described by Chauffard. Abdominal pain was the chief complaint in thirteen of sixteen cases. In Duff's series abdominal pain was present in fifteen of the sixteen cases, in fourteen as an initial symptom. The pain was dull, aching or boring or paroxysmal, most frequently epigastric and radiating to the left. The last feature was the only striking characteristic of the pain and neither Duff nor Ransom could find a constant type or location for the pain common to a majority.

In our own series of twenty-six cases of carcinoma of the pancreas, with eight confined to the body and tail, pain was an outstanding symptom in twenty-one cases. The clinical records indicate that the pain was most frequently found in the upper portion of the abdomen, but it was equally divided between right and left upper quadrants, with no apparent relation between the location of the pain and the site of the growth in the pancreas.

The clinical records in our eight cases of carcinoma of the body and tail conform to the picture first described by Chauffard and later by Ransom and Duff. Pain and emaciation were present. Jaundice developed in only one patient, late in the course.

Analysis of the eight case records shows that pain was the presenting symptom in six. The pain was epigastric in two, while it was located low in the back, to the right of the umbilicus, in the left upper quadrant, or diffuse in one each. The pain was described as dull in one case, stabbing in one, gas pain in one, colicky in one and attacks of pain in two. Weight loss was recorded in three of the eight cases. Nausea and vomiting were present in four. The duration of symptoms in seven of our cases varied from two to six months. In the eighth case the history was unreliable; apparently malignancy intervened in a cystadenoma, possibly two years before

death. Six of the group were males, varying from seventy-eight down to eighteen years in age. The ages of the females were sixty-five and thirty-four years. The average age was 53.7. In four instances an abdominal mass could be felt.

Duff listed misleading signs and symptoms in carcinoma of the body and tail in addition to the above typical findings. In the group were hematemesis, blood in the stools, distended abdominal veins, palpable spleen and liver and jaundice. The clinical records in our eight cases revealed constipation in three, ascites in five, eructations of gas in three and enlarged liver in two.

The features of carcinoma of the body and tail of the pancreas as an entity presenting a clinical picture for definite diagnosis were clearly set forth by Cabot[11] in 1938, as follows: "the early symptoms are too vague to direct attention to the pancreas. Late symptoms depend upon the part of the organ involved. Cancer of the head of the pancreas causes obstruction of the common duct, producing intense, progressive jaundice, usually without pain, and accompanied by enlargement of the liver and gall bladder. Cancer of the body or tail of the pancreas produces constant, severe boring pain in the back; if the body is involved, the pain is in the mid-back at the level of the 12th thoracic or 1st lumbar vertebra; if the lesion is in the tail, the pain is felt in the left costovertebral region or slightly higher. Jaundice and liver enlargement are not present, since the common duct is not obstructed."

It would be justifiable, therefore, strongly to suspect carcinoma of the body or tail of the pancreas when the following clinical syndrome is present: (1) A male usually above forty years of age develops upper abdominal pain which may be epigastric or in either upper quadrant, radiating to the left back, chest or scapulae, often paroxysmal or deep and boring in the back; (2) loss of weight and strength, usually within a few months; (3) absence of jaundice or mild jaundice developing late in the disease; (4) the absence of positive findings indicating specific lesions of other abdominal viscera, often coupled with the presence of one or more confusing symptoms such as constipation, hematemesis, blood in the stools, distended abdominal veins, palpable spleen or liver, eructations of gas and ascites; and (5) the presence of a mass in the midepigastrium or either upper quadrant.

DIFFERENTIATION FROM CANCER OF THE HEAD OF PANCREAS

We have for years been impressed by the massiveness of metastases in cases of carcinoma of the body and tail, and with their paucity in cancer of the head. This fact is not emphasized in clinical texts, however. A knowledge of the difference in dissemination in the two types is important in differential diagnosis and in the consideration of operative procedures.

One should know the biological behavior of carcinoma of the different sites in the pancreas in attempting a differential diagnosis. The presence of massive metastases speaks against a primary tumor of the head. Duff, in sixteen cases of cancer of the head, found four with no metastases, nine in which the metastases had not spread beyond regional nodes and liver, and only two with widely distributed metastases. He points out that carcinoma of the body and tail, on the other hand, metastasizes widely and massively. In sixteen such cases only one was free from metastases, two had metastases limited to regional nodes and liver, while in the remaining thirteen metastases had spread beyond these limits. In our eight cases arising in the body and tail, one had no metastases, two had regional node and liver involvement and five had more extensive metastases.

The operating surgeon considering radical resection of a pancreatic tumor should know the probabilities and types of metastases. Recently, Crile[12] reported successful radical resection of a highly differentiated carcinoma of the head with no regional metastases. Eight autopsies at the Cleve-

land clinic on patients dying after exploratory or palliative operations for carcinoma of the head showed that in six the tumor was limited to the resectable area. With such knowledge a surgeon can offer some patients a chance for permanent cure.

In addition to the massiveness of the metastases, Duff points out that cancer of the body and tail tends to spread more widely than that of the head. The anatomical position and relations of the body and tail favor extension to the surface of the organ, with easy widespread peritoneal implantation or penetration of transverse colon, stomach or diaphragm. Extension via lymphatics occurs widely, possibly through the lymphatics of tissues directly invaded. Direct growth into large tributaries of the portal vein, with the production of thromboses, probably favors transport of tumor cells to the liver, with abundant opportunity for massive growth.

Massive and widespread metastases to peritoneum, retroperitoneal nodes, and liver, as well as direct extension into the transverse colon, stomach, diaphragm, and large veins, often with obstruction of large intrahepatic branches of the portal vein, help to distinguish carcinoma of the body and tail from cancer of the head. These features serve adequately to explain the clinical picture and the occasional misleading symptoms.

CASE REPORTS

The following case histories serve to exemplify some of the features mentioned above and add eight more cases to the literature:

Case I. (R153-30). Mr. E. G., a fifty year old laborer, was admitted to the Creighton Memorial St. Joseph's Hospital August 29, 1930 because of abdominal pain and vomiting for seven days. Six weeks before he had become ill with chills, fever, nausea, vomiting and diarrhea for ten days and was in a hospital for what was diagnosed as typhoid fever. He left the hospital only a week before admission to St. Joseph's Hospital.

Physical examination revealed coarse râles over the lower lobes of the lungs, a mass in the abdomen just below and to the left of the xiphoid, irregular fixed pupils, a positive Rhomberg, exaggerated knee jerks and areas of anesthesia over the feet and legs.

The urine contained a trace of albumen. The gastric juice contained no free acid and the total acids were 7. There was a secondary anemia. The blood Wassermann was positive. The Widal test was negative, as were blood cultures. The spinal fluid Wassermann was positive and the spinal fluid cell count 6. *X*-rays revealed an irregularity in the upper one-third of the stomach, apparently due to pressure from behind. There was considerable irregularity in the upper stomach border and the radiologist concluded that there was a new growth in the cardiac end of the stomach. Proctoscopic examination revealed a relaxed sphincter and the anterior wall of the rectum was boggy.

The temperature varied from 100 to 105°F. and on September 15, 1930 there was some rigidity in the left upper quadrant. He became comatose and died on September 22.

Anatomic Diagnosis: Carcinoma of the tail of the pancreas with metastases to spleen, liver, retroperitoneal lymph-nodes; splenomegaly; syphilitic aortitis.

Autopsy Findings: "There is a large firm mass involving the tail of the pancreas and adherent to the hilum of the spleen; this mass cuts with increased resistance and on section is quite firm and gray. It is $7 \times 5 \times 2$ cm. In the middle of the pancreas there are 2 spherical nodules, each about 1 cm. in diameter, which on section are white with yellow spots throughout. In the head of the pancreas there are other smaller nodules. The spleen is 4 times normal size; on section it is soft and the pulp is filled with small, white masses. The liver weighs 1700 grams and contains small confluent nodules forming a mass 2 cm. in diameter on the upper surface of the right lobe." Microscopic examination confirmed the diagnosis of carcinoma of the tail of the pancreas with metastases.

This case illustrates pain in the upper abdomen, a rapid down-hill course, the absence of jaundice and metastases to the lymph-nodes, spleen and liver.

Case II. (R1625). A seventy-eight year old retired business man was admitted to

the Creighton Memorial St. Joseph's Hospital February 13, 1933 for low back pains. He had fallen on the icy pavement two months before. The pain had been getting worse. He had suffered from constipation for forty years and occasionally passed blood in the stool, the last time about a year ago. He had a hemorrhoidectomy in the same hospital three years before.

Physical examination revealed only the changes of senility. The laboratory findings were normal. The stool contained no blood. *X*-rays revealed no definite pathological condition in the gastrointestinal tract. He was discharged with a diagnosis of chronic constipation and chronic arthritis.

He was readmitted on March 3, 1933 because of the persistence of pain, mostly over the right iliac crest, constant and preventing sleep. He did not think he had lost any weight. *X*-ray of the spine and pelvis revealed a marked osteoarthritis. A barium enema showed a narrowing in the rectal lumen, due to muscular contraction. Injection of air after the expulsion of the barium failed to reveal any definite pathologic change in the rectosigmoid area. Attempts to pass a proctoscope beyond the rectosigmoid junction produced considerable pain and digital examination of the rectum revealed a mass the size of a hen's egg on the anterior wall of the rectum above the prostate. He left the hospital the following day with a diagnosis of metastatic malignancy involving the rectosigmoid region. He died at home on March 13, 1933.

Anatomic Diagnosis: Carcinoma in the tail and body of the pancreas with extension into the head; metastases to the liver and mesenteric lymph-nodes and to the peritoneum over the rectosigmoid junction.

Autopsy Findings: "The pancreas is large and nodular and on section contains nodular tumor masses. These are most marked and largest in the tail, although there are small nodules in the head. The liver is dotted throughout with white raised areas, measuring 1 to 3 cm. On section these areas are white and homogeneous. In the mesentery there are numerous, hard, large discrete masses which on section are gray to white and resemble the masses in the liver. At the junction of the descending colon and sigmoid, which is long and redundant, there is a rather hard fibrous mass binding the bowel to the abdominal wall; this mass tears with ease and the torn edges are evidently malignant tumor tissue. A similar picture is seen in front of the rectum just above the prostate, where the rectal wall is constricted and compressed, but the tumor mass here only involves the peritoneal surface."

Microscopic examination revealed carcinoma arising in the tail of the pancreas.

This case illustrates the confusing symptoms due to peritoneal metastases, as well as the massive liver metastases and the absence of jaundice.

CASE III. (R1771). An eighteen year old laborer was admitted to the Creighton Memorial, St. Joseph's Hospital December 18, 1933, for loss of weight and strength, coupled with nausea and vomiting over a five-month period. At the onset of the illness he had an occasional heartburn. In the past month he vomited practically all food eaten. The vomiting occurred from one-half to two hours after ingestion of food and later contained bile and fecal material. He had lost sixteen pounds in weight.

Physical examination revealed upper right rectus muscle rigidity persisting even after sodium amytal hypnosis. It was doubtful whether a small mass could be felt in the upper right quadrant. The urine contained six to eight pus cells per high power field. The leukocyte count was 20,800.

Exploratory laparotomy on December 19, 1933 for probable intestinal obstruction revealed extensive secondary carcinoma of the liver, with a primary growth in the tail of the pancreas. He died December 29, 1933.

Anatomic Diagnosis: Carcinoma of the tail of the pancreas, with metastases to liver and regional lymph-nodes; passive hyperemia of abdominal viscera; recent right rectus surgical incision; chronic rheumatic carditis with fibrous pericarditis and verrucous mitral endocarditis.

Autopsy Findings: "The tail of the pancreas is enlarged, nodular, gray and granular on section. The liver extends 2 fingers below the right costal margin and well over to the left. Its entire surface is covered with white, circumscribed umbilicated nodules, ranging from 1 to 4 cm. in diameter. On section these nodules range from gray to white, are granular and essentially like the nodules in the tail of the pancreas. The peripancreatic nodes are

likewise enlarged and replaced by similar tumor tissue."

Microscopic examination revealed adenocarcinoma, grade IV, primary in the tail of the pancreas.

This case exemplifies the rapid weight loss, the massive metastases and the complete absence of jaundice commonly encountered in carcinoma of the body and tail. The tumor was remarkable in that it occurred in an eighteen year old boy. In Ransom's series the youngest patient was forty and the average age 57. In Duff's series one case was encountered in the second decade and the average age was 51.2.

Case IV. (R2322). Mr. E. D. J., a sixty-three year old barber, was admitted March 29, 1936 for stabbing pain in the epigastrium of six months' duration. He had had orthopnea for the same period and had been under treatment for heart disease. He had had occasional nausea and vomiting, gradual increase in the size of the abdomen, anorexia and a thirty pound weight loss. Three years ago he had a transurethral prostatic resection.

Physical examination revealed a blood pressure of 164/94, beginning bilateral pterygium, imbedded fibrosed tonsils with injected pillars and cervical adenopathy, mucous râles over both lung bases, a heart enlarged to the left and downward, an apical systolic murmur, ascites, and a tender lower liver border. The left saphenous vein was thrombosed. There were one plus albuminuria and cylinduria. The white cells of the blood numbered 19,450, with 90 per cent neutrophile polymorphonuclears. *X*-ray studies suggested intra-abdominal adhesions with no demonstrable obstruction.

On April 12, 1936, with a preoperative diagnosis of chronic intestinal obstruction, operation revealed extensive intra-abdominal malignancy. The primary growth was not identified. A jejunostomy was done and the patient died the next day.

Anatomic Diagnosis: Carcinoma of the tail of the pancreas with extension into the omentum, metastases to the liver and lung; generalized subacute peritonitis and ascites; bilateral pulmonary congestion and infarction of the right lung base; hypertrophied left cardiac ventricle; sclerotic thickening of aortic cusp of the mitral; atherosclerosis of the aorta.

Autopsy Findings: "The peritoneum is markedly thickened and dotted with small white patches. The mesenteric fat is nodular. All the abdominal organs are matted down and adherent to the surrounding structures. In the tail of the pancreas there is a large tumor mass measuring 6 × 4 cm., white and homogeneous on section. The liver weighs 1700 grams, and over its surface are many white nodules varying in size from 2 mm. to 2 cm. On section these nodules are present throughout the liver substance." Microscopic examination revealed adenocarcinoma of the tail of the pancreas with metastases.

This case illustrates the presence of stabbing pain in the epigastrium, ascites, extensive metastases to the liver, and the absence of jaundice.

Case V. (R2406). Mr. A. A., a sixty-seven year old farmer, was admitted to the Creighton Memorial St. Joseph's Hospital July 22, 1936, because of pain in the left upper quadrant for four months. During that time he had attacks of pain, accumulations of gas, belching and nausea, coming on three to four hours after meals and during the night. The attacks lasted about thirty minutes. He seemed to get relief by eating small amounts and taking a glass of milk. The type of food seemed unimportant. His appetite was good. He was somewhat constipated.

Physical examination revealed a thin asthenic male. The tonsils were enlarged. The abdomen was soft and the wall relaxed, while there was no tenderness or rigidity and no masses were felt.

A clinical diagnosis of gastric ulcer was made and he was treated accordingly. He continued to have discomfort. On August 3, 1936, he developed fears of impending death and gradually became weaker. On August 29, 1936, he became delirious and noisy. He died on September 1, 1936. A final clinical diagnosis of gastric ulcer, dehydration and psychosis was made.

Anatomic Diagnosis: Carcinoma of the tail of the pancreas with no metastases; emaciation and dehydration; cardiac failure with pulmonary edema; chronic gastritis and chronic catarrhal enteritis.

Autopsy Findings: "A hard nodule measuring 10 × 5 cm. is present in the tail of the pancreas. On section it is gray and solid. . . . No metastases." Microscopic examination showed this to be a scirrhous carcinoma of the tail of the pancreas without metastases.

This case illustrates the clinical syndrome of attacks of pain, weight loss with nausea, and no jaundice. It failed to metastasize widely, however, and is the only one in our series without metastases.

Case VI. (R2548). Mr. W. W., a fifty-five year old rancher, was admitted to the Creighton Memorial St. Joseph's Hospital complaining of pain in the right umbilical region for five months and weight loss for three months. The pain seemed to date from an accident and a fall with severe muscle strain. A month after the accident he began to have gas pains in the abdomen, radiating up into the shoulder pits. He also began to lose weight and strength. An appendectomy was done, but he obtained no relief from the symptoms. He had required daily enemas because of constipation.

Physical examination revealed a slight limitation of movement of right lung, with a flat percussion note over the right base, as well as absence of vocal fremitus over that region. There was slight bulging of the abdomen to the right of the umbilicus; a mass was palpable in this region and in the right upper quadrant. There was flatness to dullness on percussion in the epigastrium and left upper quadrant. External and internal hemorrhoids were present and the prostate was somewhat enlarged.

On February 11, 1937 an exploratory laparotomy was done. There was found a small amount of fluid in the abdominal cavity. The liver contained many metastatic nodules. In the body of the pancreas there was a hard nodular mass. The final surgical diagnosis was "probable carcinoma of the pancreas with metastases to the liver." The pathological diagnosis on the material removed for diagnosis was "metastatic carcinoma of the abdominal wall and liver." He died on March 26, 1937.

Anatomic Diagnosis: Carcinoma of the tail of the pancreas with extensive metastases to the regional lymph-nodes, liver, peritoneum, diaphragm, chest wall and lungs.

Autopsy Findings: "In the tail of the pancreas there is a hard nodule measuring 8 × 6 cm. On section it is white and firm with scattered yellow spots. All of the peripancreatic lymph nodes are enlarged and filled with tumor tissue. The largest mass is 3 cm. in diameter. The liver is greatly enlarged and filled with tumor nodules. The largest mass is 5 cm. in diameter. On section the entire right lobe of the liver is replaced by tumor tissue which is necrotic in the center. The liver, together with the pancreas, the tumor mass and the spleen, weigh 5 kilograms. Many adhesions between liver and diaphragm and the hepatic flexure of the colon and the diaphragm. Mesenteric nodes, large and white. Cecum bound to posterior peritoneum by several large tumor nodules, the largest 2 cm. in diameter."

Microscopic examination indicated grade III adenocarcinoma of the pancreas with widespread metastases to peritoneum, mesenteric lymph-nodes, liver and lungs.

This case illustrates the presence of pain, rather rapid weight loss, absence of jaundice, with the pathological findings of widespread massive metastases to peritoneum, lymph-nodes, liver, abdominal wall and chest wall.

Case VII. (R2777). Miss E. Y., a sixty-five year old female, was admitted to the Creighton Memorial St. Joseph's Hospital January 4, 1938 complaining of epigastric pain for a period of two years. Nausea and vomiting accompanied the attacks of pain, while food only seemed to aggravate them. She had undergone treatment for colitis twelve years before in the same hospital.

Physical examination revealed slight epigastric tenderness and a mass in the left upper quadrant.

Exploratory laparotomy, with a preoperative diagnosis of splenomegaly, on January 13, 1938 revealed extensive carcinomatous involvement of the peritoneum and a large mass in the left upper abdomen involving the fundus of the stomach and the hepatic flexure of the colon. There were numerous metastases in the liver. The final surgical diagnosis was carcinoma, probably primary in stomach or colon. Biopsy of a mass in the omentum revealed grade IV carcinoma. She died January 15, 1938.

Anatomic Diagnosis: Massive carcinoma of the tail of the pancreas, with extensive necrosis of the tumor mass; extensive metastases to all

regional lymph-nodes, retroperitoneal lymph-nodes and liver; pressure deformity of the stomach and multiple erosions; varicose veins in the posterior wall of the stomach; massive adhesions in the upper abdomen.

Autopsy Findings: "The stomach, transverse colon and part of the ileum are bound together by adhesions. On the surface of the liver there are many umbilicated nodules. There are numerous adhesions about the pancreas, which contains an orange sized nodule in the tail. There are many varicose veins in the posterior wall of the stomach. . . . Retroperitoneal lymph nodes are markedly enlarged."

Microscopic examination showed the tumor to be grade IV carcinoma.

This case exemplifies recurring attacks of pain, widespread peritoneal, retroperitoneal and liver metastases, as well as absence of jaundice. Pressure upon the stomach and the presence of varicose veins, coupled with extensive adhesions in the upper portion of the abdomen, led to the erroneous diagnosis of primary involvement of stomach or colon.

Case VIII. (R3480). Mrs. H. B., a thirty-four year old housewife, was admitted December 5, 1940 to St. Catherine's Hospital complaining of a mass in the left side for five years. She was somewhat incoherent and the history was obtained with difficulty. Five years before she had noticed a small mass in the left upper abdomen. At times the mass would almost disappear, only to enlarge again. About two years ago the mass become more prominent and had extended farther down on the left side and beyond the midline. There had been no pain, but only discomfort because of the size of the mass.

She was well nourished. The skin and sclerae had a slight yellow tinge. There was a large mass in the left upper quadrant, apparently the spleen. This mass was about the size of a football. Her speech was slow. She had a secondary anemia and a leukocytosis of 15,400 with 80 per cent neutrophiles. There was a positive Malta fever agglutination test.

With a preoperative diagnosis of splenomegaly the abdomen was opened on January 21, 1941. There was found a large mass which seemed to be retroperitoneal and was possibly pancreatic in origin, with metastases to the liver. Microscopically, one of the nodules removed from the liver was metastatic papillary carcinoma. The final diagnosis was made of intraabdominal carcinoma with metastases. She died on February 7, 1941.

Anatomic Diagnosis: Cystadenocarcinoma of the body of the pancreas with perforation into the stomach and widespread metastases to the liver, regional lymph-nodes, and retroperitoneal lymph-nodes; jaundice; ascites.

Autopsy Findings: "There are about 200 c.c. of straw colored fluid in the peritoneal cavity. There is a large cyst just below and attached to the lower border of the stomach and to the pancreas; it measures 20 cm. in diameter, is smooth and yellow and on section the cyst wall is quite thick. The cyst is multilocular, the compartments filled with yellow necrotic material and varying in size from 1 to 5 cm. The cyst wall has perforated through the posterior wall of the stomach into the gastric lumen and some of the same type of necrotic material is present within the stomach. The pancreas is adherent to the inferior surface of the stomach and the superior surface of the cyst. The common bile duct has not been obstructed. There are extensive metastases in the liver, the regional and retroperitoneal lymph nodes. The liver is enlarged to twice the normal size, contains many grey to yellow nodules and weighs 3200 grams. The spleen weighs 200 grams and there are some hyalinized plaques on the surface. The gall bladder is about twice normal size and contains 35 c.c. of black, concentrated bile."

Microscopic examination revealed a papillary cystadenocarcinoma of the pancreas with metastases.

This case illustrates a rather prolonged history with an adenocarcinoma arising in the body of the pancreas, the onset of jaundice only late in the disease, confusing symptoms leading to a diagnosis of splenomegaly, while the autospy revealed massive metastases.

SUMMARY

Eight cases of carcinoma of the body and tail of the pancreas encountered in 3,500 autopsies have been reviewed.

Six of the eight cases were in men and the ages varied from seventy-eight down to

eighteen. Two were in women, aged thirty-four and sixty-five. The average age was 53.7 and one case was encountered in an eighteen year old boy.

Pain was the usual presenting symptom, in some instances occurring in attacks, but not constant enough in type or location to indicate the site of the growth.

An abdominal mass was felt in five patients.

The duration of symptoms before entering the hospital varied from two to six months in the seven cases in which the history was reliable.

Rapid weight loss was present in four cases.

Jaundice was absent in seven cases, and occurred late in one.

Carcinoma of the body and tail of the pancreas deserves more consideration when differential diagnosis of pancreatic lesions is considered. It occurs about one-third as frequently as carcinoma of the head. It presents a suggestive clinical picture with upper abdominal pain, weight loss, absence of jaundice, often the presence of a mass and confusing symptoms suggesting involvement of other intra-abdominal viscera. The pathological findings reveal massive and widespread metastases compared to those of carcinoma of the head, explaining the confusing symptoms.

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CHOLEDOCHOLITHIASIS*

A CLINICAL STUDY OF ONE HUNDRED NINE PATIENTS OPERATED UPON

HOWARD M. GANS, M.D.
Junior Assistant Surgeon, Mount Sinai Hospital
CLEVELAND, OHIO

DURING the past twenty-five years we have witnessed a remarkable change in our concept of biliary surgery. Cholecystostomy as a procedure of choice gave way to cholecystectomy with the result that the patient subjected to operation was more likely to obtain a higher percentage of permanent relief. In the past, exploration of the common duct was rarely resorted to except in instances of persistent jaundice, or when the surgeon was able to palpate a stone in a dilated duct.

In recent years with a better understanding of the pathological physiology of gallbladder disease, careful follow-up of cases, and correlation with autopsy data, our attention has been focused on the pathological findings in the common duct, such as stones, inflammatory changes, interference with the function of the sphincter of Oddi, either by mechanical interference produced by stone at the ampulla of Vater, by stricture due to inflammation in the pancreas or by spasm secondary to disturbed physiology of the sphincteric mechanism.

The work of Lahey, Allen, Walters and others has stimulated surgeons to be more conscious of disease and pathological findings in the common duct. In spite of this there are many patients who have had gallbladder surgery and who still continue to have symptoms of biliary disease. A study of the cause and relief of symptoms following cholecystectomy has been carried out by Carter and Marraffino at the gallbladder clinic of the Postgraduate Hospital, New York City[1] 485 operative cases were investigated. Three hundred seven patients had a follow-up study. Of the above 307 patients there were recurrent symptoms in 193 patients (63 per cent). Eighty-four per cent of these 193 patients were treated medically and in the remaining 16 per cent secondary surgery was required.

Pathological Physiology. Histological studies of the extrahepatic ducts reveal that the muscular coats cease abruptly at the neck of the gallbladder, at the origin of the cystic duct. The ducts are fibro-elastic tubes lined with high columnar mucosa covered by a serosal layer, with the usual subserosal areolar tissue. Only small isolated fibers of unstriped muscle, sometimes indistinguishable from connective tissue cells, are found.[2] Large glands offer lodging to organisms metastatic from other foci of infection, and they may subsequently become responsible for a low grade cholangitis.[3] Nerve fibers are present in great abundance usually distributed in the outer parts of the wall.

Schrager and Ivy[4] have reported observations on the mechanical distention of the gallbladder and biliary passages in dogs. They found that distention of the gallbladder caused distress, inhibition of respiration, nausea and vomiting. Distention of the biliary ducts caused more striking symptoms than distention of the gallbladder alone. Zollinger[5] has shown that mechanical distention of the gallbladder in humans gave rise to deep epigastric discomfort, similar to the attacks of indigestion observed in gallbladder disease. Distention of the gallbladder did not cause vomiting. However, mechanical distention of the common duct did produce vomiting and severe epigastric distress. Walters[6]

* From the Department of Surgery of Mount Sinai Hospital, Cleveland, Ohio. Service of Dr. A. Strauss.

states that "generally speaking, infection, stone formation, and obstruction of the common duct can directly or indirectly be related to inflammation which has its origin in the gallbladder." Lahey[7] believes that gallbladder disease is a progressive disease at first limited to the gallbladder and as infection goes on gradually involves the duct system.

Stone formed in the gallbladder may pass through the cystic duct into the common duct. There it may remain as a silent stone or may become lodged at the ampulla of Vater, causing obstruction to the outflow of bile. Stone or other obstruction in the common duct is followed by dilatation of the duct or thickening of its wall. Dilatation of the common duct may also occur secondary to pancreatitis or to spasm at the sphincter of Oddi. Soft stones or débris may form in the common duct, secondary to obstruction of the duct by stones, pancreatitis or sphincteritis.[8]

The stone that had its origin in the gallbladder is usually hard, faceted and does not crush easily. The soft stones found in the common duct crush easily and are seldom faceted. Occasionally, both faceted and soft stones are found in the common duct. This may be explained by the fact that the faceted stone came down from the gallbladder, through the cystic duct, into the common duct and was lodged at the ampulla of Vater causing obstruction with secondary inflammatory changes. The soft stones have formed as a result of this obstruction and secondary inflammation in the common and hepatic ducts.

A sufficiently high pressure is maintained within the common duct to force the bile into the gallbladder where it is concentrated. Stimulation such as is produced by ingestion of food can cause contraction of the gallbladder and relaxation of the sphincter permitting flow of bile into the duodenum. A simultaneous contraction of the gallbladder and of the sphincter of Oddi produces increased pressure in the bile ducts.

The pain and distress that is produced by such a phenomenon has been described as biliary dyskenesia. Best and Hicken[9] labeled this physiological obstruction of the common duct as "biliary dyssynergia." Many investigators have pointed out that cholecystectomy is followed by a marked and permanent loss of sphincter control. Doubilet and Colp[10] have shown that resistance of the common duct sphincter is about 100 mm. of water. When the gallbladder contracts, a pressure of 300 mm. of water is established. Magnesium sulfate, atropine, nitroglycerin, and amyl nitrite relax the sphincter. Morphin, stone in common duct, or hydrochloric acid produce spasm of the sphincter.

During the five-year period, from 1936 through 1940, 586 patients were operated upon at Mt. Sinai Hospital for biliary tract disease. In 477 cases, operations were confined to the gallbladder. In the remaining 109 cases, exploration of the common duct was performed, in addition to removal or drainage of the gallbladder. In the latter group, common duct stones were found in fifty-three cases, and débris was found in twelve cases. Sex incidence showed the usual preponderance of females (seventy-eight females and thirty-one males).

Table I

No. Operations	Died	Per Cent
586 on biliary tract	27	4.6
477 gallbladder alone	10	2.1
109 common duct, gallbladder and secondary operations	17	15.6
53 stones found in common duct	..	48.6
12 débris found in common duct	..	11.0
65 stones and débris	..	59.6
78 females	..	71.5
31 males	..	28.5

The majority of patients operated upon were between thirty to seventy years of age, with almost an equal distribution between the fourth to the seventh decades inclusive.

The duration of symptoms in this group of 109 cases is shown in Table III. In this

series, 30.2 per cent came to operation with symptoms of less than one year's duration; 8.2 per cent of cases had symptoms from one to two years; 19.2 per cent from two to five years; 23.8 per cent from five to ten years, and 18.3 per cent had symptoms from ten years or over.

Table II

Age Groups—Years	No. Cases	Per Cent
10 to 20	1	0.9
20 to 30	5	4.5
30 to 40	17	15.5
40 to 50	24	22.0
50 to 60	26	23.8
60 to 70	28	25.6
70 to 80	7	6.4
80 and over	1	0.9
Total	109	

Table III

Duration of Symptoms	No. Cases	Per Cent
Less than 1 year	33	30.2
1 to 2 years	9	8.2
2 to 5 years	21	19.2
5 to 10 years	26	23.8
10 years and over	20	18.8
Total	109	

history of jaundice are included as well as those cases with elevated icteric index at the time of admission to the hospital.

In the cases that had definite stones in the common duct, the incidence of vomiting was 90 per cent. Chills and fever were present in 62 per cent of the patients, jaundice in 75 per cent. In the cases in which only débris was found in the common duct, vomiting, chills and fever occurred in about the same proportions as in the cases with definite stones, but there was a higher incidence of jaundice. In the cases in which there were no pathological findings in the common duct, the incidence of vomiting was somewhat less (72 per cent). Chills and fever were present in only 27 per cent of the cases. Jaundice was present in 42 per cent.

Prior to the use of vitamin K, there was postoperative bleeding in six of the above patients with obstructive jaundice. Three died from hemorrhage, and in three cases, bleeding was controlled by repeated transfusions and by the use of intravenous calcium gluconate.

In nine of the above cases, of common duct stones, there was associated diabetes. In seven cases, the operative note read, "Pancreas was firm and enlarged." One patient was a severe diabetic for ten years, and one year prior to operation developed symptoms of pancreatitis. Following cholecystectomy and removal of stones from the common duct, here diarrhea and foul stools cleared up and she had no further need of insulin.

Table IV

	No. Cases	Vomiting	Per Cent	Chills	Per Cent	Jaundice	Per Cent
Stones in common duct	53	48	90	33	62	40	75
Débris in common duct	12	11	91	8	66	10	83
No stones in common duct	44	32	72	12	27	23	42
Total	109	91	83	53	48	73	67

In studying the symptoms of these cases, interest was chiefly directed toward those which point to involvement of the extrahepatic biliary ducts, namely, vomiting, jaundice, chills and fever. In compiling the statistics of jaundice, those with a clinical

The value of choledochography in surgery of the common duct cannot be overemphasized. The work of Mirizzi,[11] Hicken

and Best[12] and others, has stressed the importance of this procedure in determining the condition of the biliary passages as to possible physiological or pathological disturbances.

Fig. 1. Choledochogram showing filling defect in the distal end of the common bile duct and a small amount of dye in the duodenum.

Fig. 2. Choledochogram showing normal emptying of dye into the duodenum.

Recently we have used postoperative choledochography as a routine procedure. Fifty out of 109 cases of exploration of the common duct were thus studied. We have observed cases of spasm at the sphincter of Oddi, which was relieved by nitroglycerin or atropine, and cases of narrowing of the intraduodenal portion of the common duct, due to pancreatitis or edema following dilatation of the sphincter with Bakes dilators. In one case, a diagnosis of obstruction at the second portion of the duodenum was made. In nine cases we have demonstrated stones in the common duct that were overlooked at operation.

Case I. A man, aged forty-six, had an attack of middle abdominal pain radiating substernally. This occurred at 3:00 A.M. awakening him from sleep. He had had a similar attack five weeks previously. Physical examination was negative, except for tenderness under the right costal margin. Cholecystography, by double-dose method, showed no filling of the gallbladder. At operation, a gallbladder containing many stones was removed, the common duct was large and also contained several faceted stones which were removed; the common duct was drained by a T-tube. Choledochogram done postoperatively showed obstruction of the duct due to stone at the ampulla of Vater. Some dye went past the obstruction into the duodenum. (Fig. 1.)

Fragmentation and expulsion of the stone was accomplished in this case by intraductal instillation of ether, ether and oil and the use of amyl nitrite by inhalation, according to the technique outlined by Pribram[13] and Hicken and Best.[14] (Fig. 2.)

This case, in addition to showing the value of choledochography is of interest because it illustrates the fact that expulsion and fragmentation of stones is possible by the use of ether, by increasing intraductal pressure and relaxation of sphincter of Oddi by amyl nitrite. We were successful in using this method in four similar cases.

Case II. A woman, aged fifty-three, gave a history of attacks of pain in the epigastrium precipitated by fatty food, heartburn and

belching. There was no history of nausea, vomiting or jaundice. The symptoms were of several years' duration and were getting progressively worse. Cholecystography showed poor filling of the gallbladder and a cluster of large stones was visualized. At operation, the gallbladder containing six faceted stones, measuring 1 cm, in diameter, was removed. The common duct appeared to be normal, stones could not be palpated and was not explored. The patient was well for two years. She was readmitted to the hospital two years later, severely jaundiced and semicomatose. Four days prior to her admission to the hospital, she had a sudden attack of colicky pain in the right upper quadrant of her abdomen with radiation of pain to her back. On the day of her admission to the hospital, she had three severe chills, temperature 102.8°F., icteric index 130, white blood cells, 16,000. The liver edge was felt three fingers below the costal margin. A diagnosis of septic cholangitis, with obstruction of the common duct was made. At operation, the duct was large and edematous, and on opening it, pus under pressure, escaped. A T-tube was inserted; further exploration of the common duct was not attempted because of the poor condition of the patient. Her stools continued to be acholic and on the eighth postoperative day, choledochogram demonstrated obstruction of the common duct at the ampulla of Vater, due to stone. (Fig. 3.) This stone could not be dislodged by intraductal administration of ether, ether and oil and the use of amyl nitrite. Eighteen days later, the stone was removed transduodenally. The patient made an uneventful recovery. (Fig. 4.)

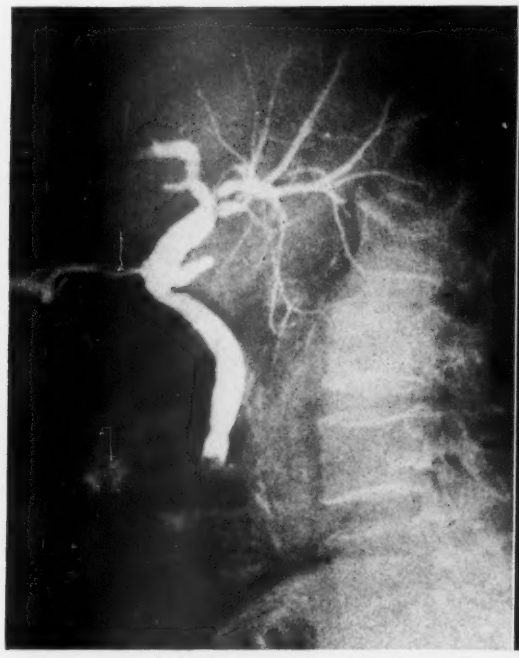

Fig. 3. Choledochogram showing filling defect at ampulla of Vater with dilatation of bile ducts.

Fig. 4. Choledochogram showing normal emptying of dye into the duodenum.

This case illustrates the necessity of exploration of the common duct even in some cases without jaundice, and that stones may be overlooked if the operator is satisfied with palpation alone.

Case III. A man, aged sixty, was admitted to the hospital with a history of upper abdominal pain, chills, fever, vomiting and jaundice of two weeks' duration. He had a gastric resection for duodenal ulcer five years previously. At the present admission, a diagnosis of septic cholangitis with stones in the gallbladder and common duct was made. At operation the gallbladder was acutely inflamed, contained many stones and pus. The common duct was large, thickened, contained many stones and débris. The gallbladder was drained, stones were removed from the common duct and a T-tube was inserted. During the postoperative

course, stools continued to be acholic. Choledochogram showed a stone impacted at ampulla of Vater. (Fig. 5.) Intraductal administration of ether, ether and oil and amyl nitrite by inhalation, failed. The stone was removed on the thirtieth postoperative day by secondary exploration of the common duct. The patient made an uneventful recovery. (Fig. 6.)

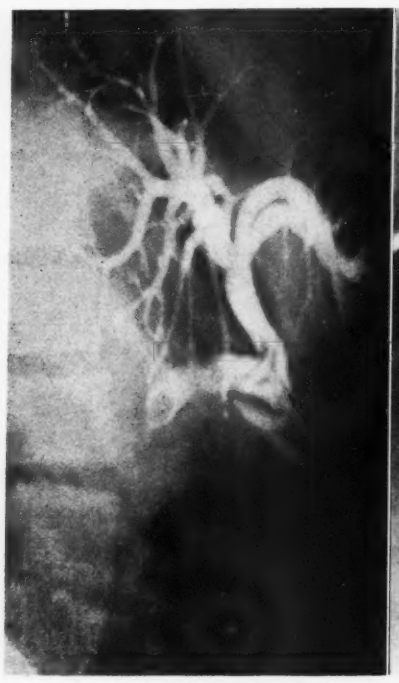

FIG. 5. Choledochogram showing filling defect at ampulla of Vater with marked dilatation of ducts.

FIG. 6. Choledochogram showing normal emptying of the dye into the duodenum.

Every surgeon must face at some time or other the problem of secondary operations on the biliary tract. These procedures are usually difficult no matter whether he himself performed the original operation, or whether the primary operation was performed by someone else. In our series, secondary operations were performed on twenty-six patients. This study was primarily directed toward determining the factors that necessitated the secondary operation. It was found that these cases may be subdivided into the following groups:

1. *Errors in judgment*—in which exploration of the common duct was indicated and was not done as illustrated in Case 11.

There were eight patients who had a cholecystostomy done previously and seven who had previous cholecystectomy. Under this heading, we might also include several cases that were subjected to secondary operations with the thought of finding stones in the common duct, but at exploration, no stones were found.

2. *Error of technic*—in nine cases studied by choledochography, there was evidence of left-over stones.

3. *Unavoidable operations*—in which the condition of the patients was such that it was impossible to complete the operation without undue risk to the patient, or in which it was intentionally planned as a two-stage procedure.

4. *Recurrent formation of stones*—due to persistent infection in the common duct. There were eleven such cases in this series. In three cases, choledochography following the primary operation showed no evidence of remaining stone, the ducts were not dilated, there was no spasm at the sphincter of Oddi demonstrable, and yet within a year, there was recurrence of symptoms and at operation, reformed stones were found.

Case v. A man, aged seventy-two, was admitted to the hospital with a history of abdominal pain, chills, fever and jaundice of six months' duration. Cholecystography showed no filling of the gallbladder and six fairly large stones. A cholecystectomy and exploration of common duct was done. The common duct contained several stones and débris. They were removed and the common duct was drained by T-tube for several months. Choledochogram done postoperatively was normal. Eight months later the patient began to complain of epigastric pain, attacks of vomiting and later of chills, fever and jaundice. He was readmitted with obstructive jaundice. After a short period of preparation, the common duct was again explored and a soft stone which crumbled easily was found impacted at the ampulla of Vater. The stone was removed and the duct was thoroughly cleaned out. His jaundice persisted for a long duration, postoperatively, but eventually cleared up, and the choledochogram was normal.

Case vi. A woman, aged sixty-eight, complained of attacks of epigastric pain, vomiting of two years' duration. There was no history of jaundice. Physical examination showed: Heart enlarged, chiefly left ventricle; E. K. G. bundle branch block; flat plate of upper abdomen showed many stones in the gallbladder area. No cholecystogram was done. Under novocain block and nitrous oxide anesthesia, the gallbladder containing many stones was removed. The common duct was large, and contained one stone and débris. This was removed, and a T-tube inserted. Choledochography later demonstrated a stone remaining in common duct. Ether and oil was injected several times and after two normal choledochograms, the T-tube was removed. The patient remained well for a year, and then returned complaining of epigastric pain radiating to the back. The liver was large and tender. Diagnosis of recurrent stone was made, and at operation, three rounded soft stones were removed from the common duct. The patient made an uneventful recovery.

With an accurate method at our disposal to study the common duct, and ability to visualize stones overlooked at operation, we also must recognize that recurrent stones in the common duct, following exploration, is not a rarity, especially when we have choledochographic evidence that no stones were left over at the previous operation. We must conclude, therefore, that continued infection within the ducts is frequently the cause of their formation. In our series of secondary operations, we had eleven cases of recurrent stones in the duct. Three cases had normal choledochograms following the first exploration. Such positive proof is lacking in the other cases, but the possibility that stones have reformed cannot be excluded.

Lahey[15] states that long continued infection within the ducts, is undoubtedly more frequently the cause of formation of stones within the ducts, than is their passage from the gallbladder into the ducts.

Out of the 586 patients who were operated upon for biliary tract disease during the five-year period, there were twenty-seven hospital deaths (4.6 per cent). The common duct was explored in 109 cases, in eighty-three as a primary operation, and in twenty-six as a secondary operation. The common duct cases accounted for seventeen hospital deaths (15.6 per cent).

Table v illustrates an analysis of the seventeen fatal cases, whose average age was sixty-two years, operative procedures performed, and details relative to death. In eight out of the seventeen deaths, we had the benefit of postmortem examination.

Three patients died of postoperative hemorrhage. These deaths occurred before the use of vitamin k. In the past two years, vitamin k has been used routinely in preparation of jaundiced patients for operation, and no deaths from hemorrhage occurred.

In two cases, associated carcinoma of the lung was found on postmortem examination.

One patient had a carcinoma of the gallbladder complicated by common duct stone, and septic cholangitis.

One patient died from pulmonary embolism and three from coronary thrombosis. Three patients died from pneumonia, and one from hepatorenal insufficiency. Three patients died from peritonitis.

Some of the patients who were admitted for secondary operations, had two or three previous operative procedures on the common duct. Most of the above patients had associated cardiovascular disease, and a history of attacks of obstructive jaundice for years.

At first glance at Table v, one notices the tremendous increase in mortality in the common duct cases, and an impression may be formed that exploration of the common duct is a dangerous procedure. Out of forty-four cases in which the common duct was explored and no stones were found there was only 1 death and that in a male, aged seventy-five, who had advanced myocardial disease. It is believed that the increased mortality in the above cases was not due to the operative procedure, but to long continued infection in the biliary tract with associated damage to the liver parenchyma. Early operations and exploration of the common duct as a primary procedure would greatly reduce the mortality in these cases.

ONE HUNDRED AND NINE OPERATIONS ON THE BILE DUCTS WITH SEVENTEEN HOSPITAL DEATHS

Age	Sex	Operation	Details	Days Post-operatively
54	F	Cholecystectomy Choledocholithotomy	Severe postoperative hemorrhage 48 hrs. after	2
50	F*	Cholecystectomy Choledocholithotomy	Postoperative hemorrhage, acute necrosis of liver	1
52	M*	Cholecystectomy Choledocholithotomy	Gas bacillus peritonitis; Lannec cirrhosis of liver	4
53	M*	Cholecystectomy Choledocholithotomy	Generalized peritonitis; stones in extrahepatic ducts	4
54	F	Drainage of common duct	Thrombophlebitis; pulmonary embolism	33
66	F*	Cholecystectomy Choledocolithotomy	Metastatic carcinoma of lung	1
64	F*	Drainage of common duct	Metastatic carcinoma of lung	7
50	F	Cholecystectomy Drainage of common duct Pus and stones	Carcinoma of the gallbladder	19
70	F	Cholecystectomy Choledocolithotomy	Complete obstruction at ampulla due to stone; bronchopneumonia	55
75	M	Cholecystectomy Exploration of common duct	Arteriosclerotic heart disease; myocardial insufficiency	24
65	M*	Cholecystectomy Drainage of common duct	Arteriosclerosis arctic stenosis; coronary occlusion	1
62	F	Cholecystectomy Choledocolithotomy	Diabetes mellitus; coronary occlusion	15
69	F	Choledocolithotomy	Hepatic renal insufficiency; third operation	19
68	M	Cholecystectomy Choledocolithotomy	Pneumonia	7
66	M*	Cholecystectomy Choledocolithotomy	Peritonitis and pneumonia	7
76	M	Cholecystectomy Choledocolithotomy	Postoperative hemorrhage	1
64	M*	Cholecystectomy Choledocolithotomy	Bronchopneumonia; bronchial asthma; hypertrophy of prostate	3

* Postmortem.

SUMMARY

1. A series of 109 cases of exploration of the common duct for stones is added to the literature for the statistical value which it may afford.

2. The pathological physiology of the extrahepatic bile ducts was discussed.

3. The value of choledochographic studies was illustrated and the postoperative use of this method was adopted as a routine procedure.

4. By the use of intraductal ether and by the administration of amyl nitrite, fragmentation and expulsion of an overlooked stone was accomplished in four cases.

5. A group of cases upon whom secondary operations on the common bile duct were performed was analyzed. In eleven cases there were recurrent stones. Three of these cases had normal choledochograms after the first operation. We believe that continued infection within the duct or disturbance in metabolism may be the cause of reformation of stones in the duct.

6. Hospital deaths were analyzed. It was believed that the increased mortality was not due to the operative procedure, but to long continued infection in the biliary tract with associated damage to the liver parenchyma, age of patients and advanced cardiovascular disease.

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All compound fracture patients must be protected perfectly against movement, muscle spasm, and loss of position. This is accomplished more easily and more efficiently by skeletal fixation of fracture fragments in plaster-of-paris casts than in any other way.
From—"Wounds and Fractures"—by H. Winnett Orr (Charles C. Thomas).

ACUTE CHOLECYSTITIS*

A REVIEW OF 140 CASES

SAMUEL MCLANAHAN, M.D.,
Visiting Surgeon, Union Memorial Hospital

HUGH TROUT, JR., M.D.
Resident Surgeon, Union Memorial Hospital

BALTIMORE, MARYLAND

AND

WILLARD WEARY, M.D.
Resident in Neurosurgery, Albany Hospital

ALBANY, NEW YORK

IN the management of acute cholecystitis, the attending physician or surgeon is confronted with the necessity of making an important early decision. His choice as to whether conservative treatment is to be followed or operation employed is not likely to be easy. Indeed, the decision has proved so difficult in past years that conscientious men have repeatedly searched their records to find help in establishing precedents or at least general principles for the proper care of this group of patients. The trend for the most part points toward earlier surgery. Many recent writers, however, have found it unwise to be categorical in their conclusions or to lay down hard and fast rules.

Anyone who undertakes to analyze a series of these cases, as we have done, is likely to be impressed with two great difficulties: The first is the difficulty of defining the term, "acute cholecystitis," and in selecting the cases to be classed within this group. The second difficulty is encountered in deducing from the records, in a manner satisfactory for statistical tabulation, the duration of the illness prior to hospital admission. By way of definition, we have included those cases diagnosed microscopically as being acute, including also a group of gallbladders which were drained because of grossly acute disease, wherein no microscopic examination was possible. The pathological criterion has been microscopical evidence of polymorphonuclear infiltration of the gallbladder wall.

The objection may be raised that all of these patients did not present the clinical picture and, therefore, the clinical problem of acute cholecystitis. While this is true, they did on the other hand present the pathological picture and were, therefore, liable to the complications and sequelae, whether recognized or not. The series considered in this study represents the records of 140 patients suffering from acute cholecystitis who were operated upon at the Union Memorial Hospital during the period from September, 1923, to November, 1940. There were twenty-seven different operators of whom twelve were Resident Surgeons and seventeen Visiting Surgeons (two were in both categories).

AGE AND SEX

Acute cholecystitis is a disease of middle and late middle life. Sixty-three per cent of the patients were between the ages of thirty and sixty. If the ages are grouped by twenty-year periods (Table 1), the largest number of patients (sixty-five) falls between forty and sixty years. Age had a very definite effect on mortality. Of 106 patients sixty years of age and under, only three died, a mortality rate of 2.8 per cent; while of thirty-four patients sixty-one and over, nine died, a mortality rate of 26.5 per cent. It can be seen (Table 1) that the rate rises with each succeeding twenty-year period.

* From the Surgical Service of the Union Memorial Hospital, Baltimore, Maryland.

Acute cholecystitis is also a disease which affects the female far more often than the male. One hundred, or 71 per cent of the patients were women, while forty, or 29 per cent were men. The men suffered a mortality of 15 per cent while the women's mortality was only 6 per cent.

Table I
COMPARATIVE MORTALITY RATES ACCORDING TO AGE GROUPS

Age Groups	No. of Cases	No. of Deaths	Mortality, Per Cent
0–20	1	0	0
20–40	35	1	2.9
40–60	65	2	3.1
60–80	37	8	21.6
80–	2	1	50.0
Under 60	106	3	2.8
Over 60	34	9	26.5

PREOPERATIVE PERIOD

Nausea or vomiting or both occurred in 85 per cent of the patients. Pain was almost a universal symptom. The palpation of a mass has been frequent though in our experience uncertain. One likes to believe in many instances that he is feeling a distended gallbladder, but the mass may well prove to have been muscle spasm, liver or gallbladder surrounded by indurated omentum and other structures.

Clinical jaundice was noted as being present in 20 per cent of the ninety-six cases in which a definite record was made. Yet in only five patients of the 140 operated upon was the common duct explored. This small number of explorations is striking and is a smaller proportion than in most series reported. One of the five died. In this hospital, the policy toward exploring the common bile duct has always been a conservative one, especially so in the face of acute cholecystitis.

The duration of symptoms prior to operation is shown in Table II. It is to be noted that nearly one-half of the patients had had symptoms for more than a week. Many of these instances of prolonged symptoms doubtless represented "acute on chronic" cholecystitis. While the numbers of cases are small, it is interesting to record that all of the deaths which took place in the first three days occurred within the first twenty-four hours. The mortality began to appear again after the third day.

Table II
COMPARATIVE MORTALITY RATES ACCORDING TO THE DURATION OF SYMPTOMS PRIOR TO OPERATION

Duration of Symptoms Prior to Operation	No. of Cases	No. of Deaths	Mortality, Per Cent
Less than 24 hours	14	3	21.4
24 to 48 hours	12	0	0
48 to 72 hours	3	0	0
4 and 5 days	26	1	3.8
6 and 7 days	15	1	6.7
8 to 31 days	42	4	9.5
More than 31 days	20	0	0
History inaccurate	8	3	36.5

The time elapsing from hospital admission until operation (Table III) represents a choice on the part of the attending physician or surgeon. Here he has had the opportunity to exercise discrimination which he may not have had in the period preceding hospitalization.

Table III
COMPARATIVE MORTALITY RATES ACCORDING TO TIME ELAPSING FROM HOSPITAL ADMISSION UNTIL OPERATION

Time Elapsing from Admission until Operation	No. of Cases	No. of Deaths	Mortality, Per Cent
Less than 24 hours	39	7	18.0
24 to 48 hours	33	2	6.0
48 to 72 hours	27	0	0
4 and 5 days	13	0	0
6 and 7 days	14	0	0
8 to 31 days	14	3	21.4

A striking fact is the high mortality (18.0 per cent) in the group operated upon within the first twenty-four hours. This corresponds with the "immediate" group of Cave.[1] Out of fairness to this group, it must be conceded, however, that it includes

the sickest patients, those who might not do well under any form of treatment. Within the following twenty-four hours there was a mortality rate of 6.0 per cent while in the next five days, there were no deaths at all in fifty-five cases. This same trend in mortality over a period of time is recorded by Fallis and McClure,[2] Bonn and Bachhuber,[3] Smith,[4] and many others. It is a significant observation.

Preparation of the patient for operation is admittedly essential when a definite diagnosis has been made. Only in rare instances is a surgeon justified in operating as quickly for cholecystic disease as he would for appendicial disease. Restoration of the biochemical balance, sedation and rest are essential elements of the treatment. This period will often involve "overnight" or even twenty-four hours. However, almost every surgeon of experience can recall one or more instances of the discovery of acute cholecystitis as the responsible lesion when he has made a working diagnosis of perforated ulcer, acute appendicitis or a similar condition requiring immediate surgery. In retrospect, such a patient might have been benefitted by a longer period of preparation, but the diagnostic difficulties forestalled that opportunity.

Once the patient has been "prepared," the crux of the matter is the *pathological state* of the gallbladder. And this pathological state is likely to remain the treasured secret of the abdomen until either the illumination of the operating room or postmortem chamber exposes it, or an undisputed cure heralds its disappearance. Surgeons are apt to emphasize to victims of appendicitis the possible discrepancies between clinical signs and pathological changes. How much greater is that discrepancy in the instance of cholecystic disease! Behrend and Gray[5] have correlated clinical, surgical and pathological diagnoses in 200 cases and have found wide variations. Fallis and McClure[2] noted a marked difference between the incidence of such complications as gangrene and empyema of the gallbladder in the surgical and pathological diagnoses. The surgical incidence was always higher than the pathological one. Touroff,[6] Heuer,[7] Mitchell,[8] and Hotz[9] have all noted that the symptoms of acute cholecystitis may subside and yet the lesion may progress. A partial explanation of this phenomenon may well be that the pathological changes of gangrene and perforation are largely dependent upon vascular occlusion, usually thrombosis of the cystic artery. This is hard to predict and impossible to combat.

As a result of these observations, it appears logical that the patient whose symptoms are persisting or are slowly subsiding should have the advantage of prompt operation. A progressive pathological change may thus be arrested. The patient whose symptoms have rapidly diminished is entitled to further diagnostic study if necessary, and may then be managed as a case of chronic cholecystitis. Operation will then usually be advised to avoid any recurrence of the attack and again to obviate the chance of a continuing acute process, even though that chance is remote.

OPERATION

From the *diagnosis at operation*, there were fourteen cases (10 per cent of total) which showed perforation. Six of these patients succumbed, a mortality rate of 42.8 per cent. Forty cases (29.2 per cent of total) showed gangrene including nine which had perforated. Of these forty cases, 7 patients died, a loss of 17.5 per cent. Of 139 patients with complete records, 103 were diagnosed grossly as having acute cholecystitis in one form or another and thirty-six as being chronic or subacute. One patient in the latter group who succumbed had been subjected to a gastric resection in addition to cholecystectomy.

The advantage of cholecystectomy over cholecystostomy is generally admitted. Many writers have expressed definite opinions on this matter including Smith,[10] Stone and Owings,[11] Heuer,[7] and Fowler.[12] Fallis and McClure[2] were able to state that the gallbladder was removed in all 320

patients in their series. This indeed is a remarkable record. There are times, however, when the operator is thoroughly justified in limiting the operation to drainage of the gallbladder, because anything further might be at the risk of life or serious complication. For instance, attempts at separating the gallbladder from a densely adherent duodenum might run an unnecessary risk of duodenal fistula. Excessive inflammation about the ducts may well be a contraindication to removal of the organ in an especially ill patient. In our experience, however, it is difficult to tell very much about the duct area until the operation is well advanced. If the gallbladder is being removed from above downward, which we believe to be the safest way in these cases, the ducts can usually be safely identified. If not, the gallbladder can be amputated at a level which is safe and a small fragment left behind. Although on two occasions we have thus cut across the gallbladder removing the major portion, we have in each instance by that very act obtained so much better exposure that the ducts were readily identified and the remaining fragment removed, with satisfactory ligation of the cystic artery and cystic duct. Partial cholecystectomy as advocated by Estes[13] or as advocated by Thorek[14] has not been carried out in this series.

Table IV
COMPARATIVE MORTALITY RATES ACCORDING TO TYPE OF OPERATION PERFORMED

Type of Operation	No. of Cases	Per Cent of Total	No. of Deaths	Mortality, Per Cent
Cholecystostomy.	28	20	7	25.0
Cholecystectomy.	112	80	5	4.5
Total.....	140	100	12	8.6

The patients who have been subjected to cholecystostomy have for the most part been either extremely ill or have had complicating circumstances. This accounts in part at least for the higher mortality of this operation. The mortality in this series in twenty-eight cases of cholecystostomy was 25 per cent, while that in 112 cases of cholecystectomy was 4.5 per cent. (Table IV.) Hotz[9] reports a 29.6 per cent mortality in fifty-seven cholecystostomies and believes that the disproportional mortality cannot be entirely ascribed to the poor risk of the patients. Furthermore, he points out a high mortality rate (20 per cent) among his series for patients who survived cholecystostomy but returned later for cholecystectomy. This may be taken as an added argument, if one is needed, for primary removal of the gallbladder. Certainly, personal experience has convinced us of the great technical difficulties inherent in the secondary removal of a previously drained gallbladder.

POSTOPERATIVE COURSE AND COMPLICATIONS

Although statistics are not available to prove the point, it is our distinct impression that patients today have far smoother courses following cholecystectomy than they did when less attention was paid to fluid balance and especially to the value of intravenous glucose. The administration of glucose before operation, at the operating table and during the early postoperative days has meant more in avoiding prolonged nausea and functional liver disturbances than has any other factor. Nevertheless, a large percentage of patients undergoing operation for acute cholecystitis will have complications, many of them serious. In this group 31 per cent developed some complication.

Pulmonary complications were recorded as occurring in six patients or 4.3 per cent of the series. There were three cases of pneumonia, two of them fatal, one case of atelectasis, one case of pulmonary infarction and one case of massive collapse of the lung. Myocardial disturbance occurred in four instances, or 2.9 per cent of all the patients. Three of these patients succumbed, two of "cardiac failure" and one of auricular fibrillation coupled with uremia. The fourth case developed auricular

fibrillation but survived. Peritonitis was given as the cause of death in four cases, making an occurrence of 2.9 per cent. The failure to obtain positive cultures from the contents of the gallbladder in many instances of acute infection is one explanation for the low incidence of peritonitis. Postoperative hemorrhage occurred twice and was fatal in one case. Other fatal complications occuring in one case each were shock and intestinal obstruction. In addition there were two cases of saphenous phlebitis and one case of evisceration. Prolonged drainage or wound infection took place in eleven patients or 7.8 per cent. The remaining twelve patients had complications of a minor degree or of extreme rarity.

Although the sulfonamide drugs have not been used sufficiently in this group of patients to warrant any statistical deductions, these drugs will undoubtedly prove helpful in combating many of the complications of acute cholecystitis. These complications are quite comparable to those of acute appendicitis in which morbidity has been lessened materially by their use.

MORTALITY

There were twelve deaths in the 140 cases subjected to operation, a mortality rate of 8.6 per cent. Seven of the deaths occurred among the group of twenty-eight undergoing drainage of the gallbladder, yielding a mortality rate of 25 per cent for this group, while five deaths occurred among the 112 patients undergoing cholecystectomy, a mortality rate of 4.5 per cent. The gallbladders of the seven patients who succumbed following cholecystostomy were all gangrenous, five of them having perforated. Of the five patients succumbing after cholecystectomy, the gallbladders of three were gangrenous and of two were acutely inflamed without gangrene. There were three autopsies. Death was apparently due to peritonitis in four instances, to cardiac failure and to pneumonia in two instances each, and to hemorrhage, auricular fibrillation, intestinal obstruction and shock in one instance each. There were no instances in which hyperpyrexia and coma preceded death, suggesting hepatic insufficiency or "liver death." Operation within the first twenty-four hours either after onset or after hospital admission carried a higher mortality than during subsequent days.

DISCUSSION

In general, early removal of the acutely inflamed gallbladder gives satisfactory results. However, immediate operation following hospital admission is rarely advisable and in fact is only recommended when the differential diagnosis from a condition requiring such surgery is not possible or when a free perforation is suspected. A period of preparation is undertaken during which time the fluid balance is restored, the liver glycogen augmented and the patient given sedatives. During this period of observation it may be possible to ascertain in general "which way the wind is blowing." While it is to be emphasized that clinical signs and pathological changes do not altogether coincide, the clinical changes are at least the best indication available of the direction the trend is taking. Thus if the temperature and leucocyte count are rising, and the abdominal tenderness increasing, the indication is for prompt exploration. If, on the other hand, the reverse is true, the logical course is to let the patient improve and gain what he can from a short period of more normal physiological processes. Operation may then be carried out safely within a week from the time of his hospital entry. In this way one is enabled to use the time element to the advantage of the patient within the limits of the errors of personal judgment. One cannot be entirely categorical in this matter, but must rather exercise intelligent judgment based on his own experience and the experience of others, toward the end of prompt and sustained recovery.

SUMMARY

1. Difficulties in defining "acute cholecystitis" and in deducing accurate informa-

tion about the duration of symptoms prior to hospital admission are encountered in any such study.

2. Acute cholecystitis is a disease of middle and late middle life. Mortality was definitely affected by age, the rate for those who were sixty years of age and under being 2.8 per cent while for those over sixty, it was 26.5 per cent.

3. Jaundice was noted in 20 per cent of the recorded cases; yet in only five of the 140 operations was the common bile duct explored. This illustrates an extremely conservative point of view as regards choledochostomy.

4. Approximately one-half of the patients had had symptoms for more than a week. While the mortality was highest in the fourteen patients operated upon in the first twenty-four hours, it became high again only after a week. Considering mortality again on the basis of time elapsing from hospital admission to operation, the rate was still highest for the first twenty-four and even forty-eight hours but was nil for the next five days, rising again by the eighth day.

5. The pathological state of the gallbladder becomes the crux of the matter, but its determination is difficult due to the discrepancy between clinical signs and pathological changes.

6. The operation of cholecystostomy was accompanied by a mortality rate of 25 per cent while for cholecystectomy the rate was 4.5 per cent. While this is partially explained by the greater degree of morbidity of patients undergoing the former operation, it emphasizes the importance of complete removal whenever possible.

7. Thirty-two per cent of the patients developed some postoperative complication. These complications are listed.

8. The total mortality rate for 140 cases was 8.6 per cent. Ten of the twelve gallbladders of patients who died were gangrenous. There were no instances of "liver death."

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PREVENTION OF SHOCK IN SPINAL ANESTHESIA

LILLIAN E. FREDERICKS, M.D.
PHILADELPHIA, PENNSYLVANIA

MOST authors now agree that spinal anesthesia, if properly used, is the nearest to an ideal anesthetic. The steadily increasing number of spinal anesthesias administered supports this statement. Stanley,[39] judging from twenty-five years, experience, states that "the use of spinal anesthesia in the majority of cases is preferable to that of inhalants."

Much has been done to make spinal anesthesia a safer procedure since the time when August Bier, in 1898, first used it.[28] However, there is still considerable to be done to make spinal anesthesia safer.

The advantages of spinal anesthesia are manifold. Maxson,[28] Schlaepfer,[34] Graham and Brown,[17] Newton,[31] Youngblood,[45] Foss and Bush[33] and others have discussed them in detail, hence the most important only will be considered.

This method provides optimal surgical anesthesia with complete muscular relaxation making an atraumatic operative dissection possible. The intestines are contracted and reduced in size, giving the surgeon more room for easy palpation and exposure without traumatizing by packing away of distended loops of intestines and there is no necessity for forceful retraction. By avoiding trauma postoperative adhesions as well as discomfort, distention and gas pains are decreased. The hyperperistalsis of the intestines and the relaxation of the anal sphincter cause the passage of flatus reducing the amount of gas present. During rectal operations the complete relaxation of the anal sphincter is of the utmost importance. All these conditions, favorable for the surgeon, improve his technic and shorten the operative period.

The gentleness with which a perforated duodenal ulcer or ruptured appendix can be exposed and the absence of various respiratory efforts which are associated with the induction of inhalation anesthesia and which promote the spilling of the intestinal contents, greatly decrease the mortality from these conditions. Graham and Brown[17] go so far as to say: "A surgeon who operates upon a patient suffering with acute intestinal obstruction using inhalation anesthesia if adequate facilities for spinal anesthesia are available, is guilty of malpractice."

Due to the decrease in blood pressure, the amount of bleeding is less. According to Schlaepfer[34] there is much less evidence of postoperative shock than after the use of any other form of anesthesia. This is due not only to the decreased amount of trauma and hemorrhage but also to the blockage of shocking influences coming from the operative field because of the interruption of the afferent nerve path by the anesthetic. Postoperative nausea and vomiting is practically negligible.

The cough reflex is not abolished, which is of great importance in chest surgery as well as in preventing the development of atelectasis and pneumonia which may follow general anesthesia.

Further advantages are that no complicated apparatus is necessary, that emergency operations may be performed on a patient who can not be prepared and who, because of his full stomach, would be unfit for inhalation anesthesia. There is no respiratory, cardiac, hepatic or renal irritation and, therefore, no contraindication to the use of spinal anesthesia in the presence of tuberculosis or otherwise damaged lungs or kidneys. It is especially indicated in diabetes. Altman and Fenz[1] showed that after spinal anesthesia the increase in blood sugar is much less than after ether anesthesia.

However, spinal anesthesia has some disadvantages: It is a "one shot" procedure; the entire calculated dose must be given at

one time and the relatively short duration limits the operative time. This, however, is eliminated by the "continuous spinal anesthesia" method of Lemmon[26] to be discussed later.

There are certain limitations as to the age of the patient. Co-operation of the patient is essential and cannot be expected from children. In the aged it has the usual dangers of any other kind of anesthesia.

The limitation to operations beneath the diaphragm is controversial and there are a number of reports in the literature of spinal anesthesia having been used successfully and without great mortality in operations on the chest, neck and head.[3,8,12,13,19,28,31]

Burch, Harrison and Blalock[4] have shown that the tolerance to hemorrhage is less under spinal anesthesia than under ether. Maxson[28] is of the opinion that "the chief danger of spinal anesthesia is the lack of experience and judgment of the anesthetist" and supports this statement by the fact that all statistics on spinal anesthesia mortality show a higher death rate in the first one hundred injections, with a constantly decreasing level in a larger series.

The coincident fall in blood pressure which occurs in about fifty-nine out of sixty cases according to Goldfarb, Provisor and Koster[16] and the development of a shock-like state which is occasionally seen are of great disadvantage and danger. A thorough understanding of the causes of the development of the fall in blood pressure and shock in spinal anesthesia will, however, enable the anesthetist to prevent its occurrence and make spinal anesthesia a very safe procedure.

The causes of mortality in spinal anesthesia can be divided into two groups: Those that are due to allergy to the drug itself and those due to circulatory or respiratory failure. The former group is very rare and almost unavoidable except by skin testing. The latter group is avoidable and can be effectively dealt with by a competent anesthetist.

Most workers[27,29,30,42 et al.] agree that circulatory failure or shock is the result of an uncompensated disparity between the blood and the volume capacity of the vascular system. Meyler[29] explains that this disparity is caused by a decrease of the blood volume due to loss of blood, dehydration or exudation of plasma, an increase in vascular capacity or a combination of both.

Normally, there are certain compensatory mechanisms that tend to restore the loss of blood volume by discharge of blood from reservoirs like the spleen and liver or absorption of fluid from other sources. Other mechanisms tend to decrease the volume capacity of the vascular bed by constricting various parts. Eppinger[10] has shown by *x*-ray that the size of the heart is decreased under such conditions; arteries are constricted, peripheral veins are collapsed and venules and capillaries may or may not be constricted. As long as these compensatory mechanisms are active and compensation sufficient, there will be no great fall in blood pressure. But when compensation fails, the blood pressure falls rapidly and progressively. Moon[30] says that this is not a sign of the onset of shock but of a departed opportunity and that treatment in order to be effective must be instituted before the development of circulatory failure. In other words, the treatment of shock is its prevention.

Everybody is familiar with the mechanism of the development of shock following a diminution of blood volume by excessive loss of blood or dehydration. That exudation of larger quantities of plasma into the tissues may cause shock is one of the older theories that has been evaluated and substantiated by the experiments of Eppinger, Kaunitz and Popper[11] published in 1935. They spoke of the state of "Seroese Inflammation" characterized by a concentration of hemoglobin, by an increased number of red blood cells and by a high hematocrit in the presence of normal plasma proteins. They concluded that plasma must have been lost from the circulation and proved this in their experiments by showing an increased production of lymph in animals in histamin shock.

Moon[30] worked along the same lines and popularized this theory in this country, especially by his articles published in 1940.

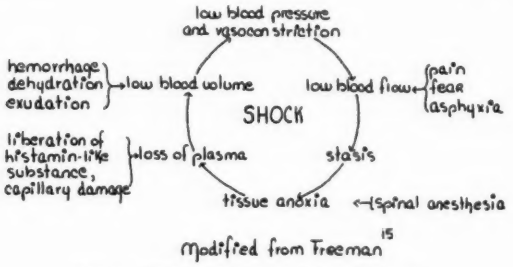

FIG. 1. The vicious circle of shock.

He points out that the capillary endothelium is a very delicate structure and that it is affected by various injurious agents like products of cellular catabolism, hormonal substances, anoxemia, etc. All these observations have been known for quite some time[24,25] but he emphasized the fact that any marked reduction of blood volume flow, produced by whatever agent or mechanism it may be, will reduce the oxygenation of the tissues. This produces anoxia and subsequent capillary dilatation, with increased permeability and leakage of plasma into the tissue, causing hemoconcentration and the whole train of signs and symptoms accompanying the clinical picture of shock. He says: "Capillary atony and tissue anoxia are the main factors in the mechanism of this type of circulatory deficiency. Either of these factors induced primarily by whatever means, presently causes the development of the other. This constitutes a reciprocal relationship which gives the circulatory deficiency a selfperpetuating quality." This statement seems to be the most important concept of Moon. The realization that shock is not a static condition due to one cause but that it is a process that may be initiated by a number of things is the clue to the understanding of this complicated and much discussed problem. It seems that most investigators, although expressing so many diverging opinions about the cause of shock, were right but they did not go far enough. Probably each of the proposed causes does lead to shock but they assumed that the factor under investigation was the sole cause, not realizing, until very recently, that it is only one factor in a larger problem. It does not matter whether shock is primarily due to a histamin-like substance liberated at the site of a large injury causing increased permeability of the capillary walls, whether it is due to fear or pain reflexly causing vasodilatation and capillary atony, an anesthetic paralizing the vasoconstrictor nerves, or due to lack of venous return, etc. The important thing is that, if not adequately compensated, each of these factors leads to one of the conditions that is part of the vicious cycle producing a disparity between the effective blood volume and the available capacity of the vascular system. This expresses itself in the clinical picture of shock. (Fig. 1.)

The occurrence of an increase in the vascular capacity and its relation to shock needs some consideration. Normally, capillaries maintain a certain tone and only part of them are open at one time. However, under certain conditions, for example under the influence of poisons, toxins or even partial anoxia[30] the capillaries become atonic and do not respond to stimulation, thus withdrawing a great amount of blood from the circulation. Because of the excessive number of open capillaries and because of their atonic state, the capacity of the vascular bed is greatly increased. Dilatation of the capillaries further increases their permeability, leading to further concentration of the blood. Meyler[29] points out that under such circumstances blood taken from a finger prick shows a higher concentration of hemoglobin and a larger number of red blood cells than blood taken from the cubital vein. That the blood flow is much slower in such dilated capillaries and that this leads to stasis and at least to a partial tissue anoxia is easy to understand. Tissue anoxia is also produced to a certain degree by the compensatory constriction of arteries and arterioles.

Thus we see that increase in capacity of the vascular bed and decrease in the actual or effective blood volume flow aid and

promote each other in the production of shock.

A fall in blood pressure under spinal anesthesia occurs in a very large percentage of cases, one can say in almost every case. The extent of the fall varies with the individual, with the general condition of the patient and, to a certain degree, with the extent of the anesthesia. According to Maxson[28] it begins eight to ten minutes after injection, reaches a maximum in twenty to thirty minutes and gradually rises returning to the original level in another half hour if there is no operative shock or hemorrhage. White,[43] Schubert[35] and Henderson[21] among others point out that the cause of the circulatory disturbance lies not in the heart but in the periphery and consider the fall in blood pressure found in spinal anesthesia to be an expression of peripheral circulatory insufficiency, i.e., shock.

If we consider some of the events occurring in the body that are induced by spinal anesthesia injected high enough to allow work in the upper part of the abdomen, we easily can see how many factors are present which may initiate the vicious circle of shock.

Goldfarb, Provisor and Koster,[16] Doud and Rovenstine[9] et al. showed that there is a fall in systolic and diastolic blood pressure, a decrease in pulse rate, an increase in the circulation time, a decrease in venous pressure and a decrease in cardiac output. Besides this there are a vasomotor paralysis causing vasodilatation and a considerable increase in the volume of the peripheral vascular bed, a loss of resistance in the skeletal muscles which are no longer able to support the vessels adequately, leading to a pooling of the blood in the dependent parts with a reduction of blood in the effective circulation, and a fall in the respiratory volume due to the paralysis of the intercostal muscles. This leads, not only to a decreased return of oxygenated blood to the heart, but also to a decrease in venous return due to the diminution of the negative intrathoracic pressure which has been shown to play an important part in aiding the return of blood to the heart.[18,20,21,41,44 et al.] The depletion of tissue oxygen during high spinal anesthesia has been shown by Seevers and Waters,[36] Co Tui,[7] Lamb, Shaw and Steele,[37] Novak and Downing[32] as quoted by Burford and Leigh.[5] They showed that there is a great decrease in the oxygen content of the venous blood. Shaw, Steele and Lamb[37] in their experiments on dogs produced a typical example of stagnant anoxia by the induction of spinal anesthesia. The pooling of blood and the presence of anoxia in blood and tissues, as stated before, is considered one of the important factors in the development of shock.

Furthermore, during spinal anesthesia the compensatory mechanisms which normally come into play are made largely inactive by the paralysis of most of the white rami carrying vasoconstrictor fibers and emerging from the first thoracic to the second lumbar segments. The experiments of Burstein[6] on dogs also clearly indicate that there is a paralysis of the compensatory mechanism which normally regulates the blood pressure level following postural changes. Whether the paralysis of the sympathetic vasoconstrictor nerves is primarily responsible for the lack of adequate compensation or whether this is merely secondary to a depletion of adrenalin due to paralysis of the suprarenals has not yet been definitely proved. In any event the decreased power of compensation is soon followed by all the signs and symptoms of the disparity of the effective blood volume and the capacity of the vascular bed, that is by shock.

There are certain precautions to be taken before the institution is spinal anesthesia. The selection of patients is a very important point. Many of the earlier mortality statistics are high because spinal anesthesia was administered to moribund patients, to patients already in shock, and to others who could never have survived any other kind of anesthesia.

There are a few contraindications to spinal anesthesia which are accepted by most authors. They are: shock, marked toxemia, septicemia, or pyemia in which latter case a septic localization in the spinal cord is to be feared; lues, meningitis, epilepsy, apoplexy, tumors or any other lesions of the meninges or spinal cord; decompensated cardiovascularrenal disease; pleural or pericardial effusions in which ventilation already is markedly decreased; marked hypo- or hypertension; conditions that seriously interfere with the movements of the diaphragm such as extreme ascites or pregnancy with hydramnion; also any infections of the skin or other tissues around the site of injection. Elderly patients with arteriosclerosis and a history of previous vascular accidents, extremely obese patients not only because they are bad risks for any kind of anesthesia but they also may not tolerate the Trendelenburg position which may be necessary, and children and extremely nervous patients who cannot tolerate being conscious during the operation should not be given spinal anesthesia.

Proper preparation of the patient and adequate premedication is of great importance. The administration of sedatives the night before and on the morning of the operation and the reassurance of the patient with a few kind words greatly aid in the smoothness of the procedure. The routine use of ephedrine preoperatively in order to prevent the fall of blood pressure is not universally accepted. Babcock[2] and Hellmann[20] among others are against its use because it increases the work of the heart, is unreliable in emergencies, tricky and potentially dangerous. Besides, it does not act on the capillaries and as Moon[30] points out the arteries are not dilated in circulatory failure and ephedrine does not help the capillary atony and increased permeability caused by tissue anoxia.[38] However, most anesthetists use it either fifteen to twenty minutes before or right after the injection of the anesthetic, apparently to advantage. Therefore, the decision has to be left to the judgment of the anesthetist. Maxson advises the use of ephedrine only in selected cases and not as a routine.

It is important that the patient is under proper sedation during the time of operation. Lemmon[26] advises that the patient should have so much morphine and scopolamine before and during the operation that he will be semiconscious and fall asleep while on the table. Other authors do not approve of the extensive use of morphine during spinal anesthesia.

The patient should be in Trendelenburg position during the operation.[28,39,41,45 et al.] This is necessary to prevent a fatal cerebral and cardiac anemia and to enable the cardiovascular system to function properly with the aid of gravity. There are no dangers of upward extension of the anesthesia to higher and more dangerous levels when the most frequently used and safest anesthetic, namely, procain hydrochloride (novocain, neocain) is used as shown by Koster, Shapiro and Leikensohn.[22]

The use of oxygen during spinal anesthesia has a dual purpose. It relieves the nausea that is sometimes experienced by the patient and it increases the amount of oxygen carried in the blood and delivered to the tissues during the abnormally slow passage of the blood, and thereby breaks the vicious circle that is induced by tissue anoxia during spinal anesthesia.[5] Lemmon gives a continuous venoclysis of 10 per cent glucose to support the patient during the operation.

What has been said about the use of ephedrine preoperatively also holds true for the administration during the anesthesia excepting that it seems to be of no value in cases with great fall in blood pressure and shock because of its slow action, as it does not start until about fifteen minutes after injection.

Perla, Freiman, Sandberg and Greenberg,[33] Moon,[30] and Swingle, Parkins, Taylor and Hays[40] advise the use of adrenal cortical hormone for the prevention and treatment of shock. This hormone seems to

be concerned with the maintenance of the capillary tone. However, it has not yet been used to any large extent so that its value during spinal anesthesia has not been proved.

Last but not least the care for the comfort and psychic state of the patient is essential. The value of a well trained anesthetist who reassures the patient before and during the operation and cares for the patient's psychic and mental comfort cannot be overestimated. Occasionally, the fear and nervousness of the patient can lead to grave complications and this is one factor that usually can be prevented.

During the transportation of the patient back to his room sudden changes in position should be avoided, since the vasomotor system is not yet capable of compensating adequately for postural changes. The continuation of the Trendelenburg position accomplished by elevating the foot of the bed a few inches is very valuable in the prevention of the headaches that sometimes occur after spinal anesthesia. Intravenous infusion of normal saline has the same advantages as after general anesthesia.

Lemmon[26] describes a technic for continuous spinal anesthesia, in which the spinal needle is not withdrawn after the injection of novocain so that subsequent doses may be introduced as needed. In a series of about 200 cases he reports very favorable results. The continuous method enables us to eliminate several of the disadvantages of spinal anesthesia such as the administration of the entire calculated dose at one time and the limitation of the operative time. Thus Lemmon reports a maintenance of analgesia as long as four hours, requiring several doses of novocain. Furthermore, Koster, Shapiro, Warshaw and Margolick[23] showed in their experiments that the duration of the paralysis of the lower extremity induced with procain can be markedly shortened by the withdrawal of spinal fluid. This can easily be done during continuous spinal anesthesia so that, when any untoward reactions to the induction of the anesthesia occur, some of the spinal fluid mixed with the drug may be withdrawn.

Altogether the use of the continuous method seems to have many advantages over the "one shot" method and seems to aid considerably in the safety of production of the anesthesia as well.

SUMMARY AND CONCLUSIONS

1. The great value of spinal anesthesia is indicated.

2. The disadvantages and dangers and the cause of mortality in spinal anesthesia are discussed and the conclusion reached that a thorough understanding of the processes producing a fall in blood pressure and the development of shock during spinal anesthesia is absolutely necessary for prevention of this phenomenon.

3. The modern conception of shock is outlined and the point stressed that shock is not a static condition due to a single cause, but a process that may be initiated by a number of things, any one of which may lead to the vicious circle of shock.

4. It has been shown that during spinal anesthesia ascending high enough to allow work in the upper abdomen, many factors are present that may initiate the vicious circle of shock and that this can be prevented by certain precautions taken before, during and after operation and by intelligent management during spinal anesthesia.

5. The advantages of the use of a continuous spinal anesthesia are mentioned as well as its value in increasing the safety of spinal anesthesia in general, which form of anesthesia seems to be gaining greatly in popularity due to its efficiency if properly used.

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THE DOUBLE PIN METHOD IN THE TREATMENT OF FRACTURES OF THE TIBIA AND FIBULA*

MILTON J. WILSON, M.D. AND ALAN R. CANTWELL, M.D.
Associate Professor of Orthopedic Surgery, New York Medical College and Flower Fifth Avenue Hospital
Instructor in Orthopedics, New York Medical College
NEW YORK, NEW YORK

THE economic trends in the past few years and the introduction of speed into our civilization have brought about rapid and drastic changes in our treatment of fractures involving the tibia and fibula.

In 1937, fractures of both bones of the leg with displacement were being treated by the introduction of a single Steinman pin through the os calcis and skeletal traction-suspension. This did not appeal to us because it required weeks of recumbency in bed and prolonged hospitalization. At this time many apparatuses for traction and distraction appeared on the market, so we decided to try the method.

Instead of placing one Steinman pin through the os calcis for direct skeletal traction we began to place an additional pin through the upper end of the tibia in order to obtain distraction of the fragments.

We believe, as do others, that too much emphasis has been placed on the open reduction of fractures for the purpose of accurately approximating bony fragments. In so doing the ultimate functional results obtained by conservative measures have been lost sight of. Many men have so keyed their senses that nothing but a perfect anatomical reduction appeals to them. While anatomical reposition of the bones is desirable, it is not a prime requisite to a good functional result. The *x*-ray has made us conscious of our inability to secure perfect anatomic results, and has also made our patients conscious of slight discrepancies which, as a matter of fact, are unimportant from a functional stand point.

To quote Dr. Paul Magnuson, "Plates do not reduce fractures. The fracture is reduced not by the apparatus but by the intelligent application of the fundamental principles underlying the treatment. This implies a knowledge of the anatomy, pathology, and the mechanical principles involved."

ROUTINE PROCEDURES

1. Given a fracture of the tibia and fibula, preliminary immobilization in a Thomas splint or two lateral and one posterior bass wood splints to the upper thigh is necessary. If *x*-ray examination reveals a fracture of the shaft of the tibia and fibula with a tendency to displacement of the fragments, the patient is anesthetized under general anesthesia.

2. The skin is prepared with iodine and alcohol from the toes to the upper thigh. A Steinman pin is introduced through the os calcis by making a small vertical incision through the skin, one thumb's breath below the external (fibular) malleolus and on a line with the posterior margin of the fibula. The Steinman pin is then introduced through the os calcis with the aid of a Steinman pin holder. When the point is seen to protrude through the skin of the medial aspect of the os calcis, a similar vertical incision is made. If the incision penetrates too deeply, a moderate amount of bleeding occurs due to the venous anastomosis over the heel. A second pin is passed through the upper end of the tibia at the level of the tibial tubercle about one inch behind the anterior surface of the

* From the Orthopedic and Fracture Service of the Flower Fifth Avenue and Metropolitan Hospitals, New York City.

bone. The Steinman pin will not produce pain unless there is a drag on the skin. It is, therefore, important to check on the skin tension after the pins are inserted. Following the insertion of the Steinman pins the incisions are sealed over with cotton impregnated with collodion. No difficulty will be experienced inserting the pins at these levels if sufficient rotary pressure is used, because the bone of the os calcis offers no resistance to the introduction of the Steinman pin. However, if the pin is placed too low in the tibia, the hard cortical bone may bend the pin or break off its sharp point. These pins are stainless steel and not vitallium.

3. The limb is then placed in the apparatus (MacMillan), and pins fixed in position. Traction is applied to the distal pin through the os calcis. The proximal pin, through the upper end of the tibia merely maintains countertraction. Most cases are reduced with the aid of the fluoroscope. The fragments can be felt by manipulation; and if too much traction is made, the fracture line will gape. The reduction should be checked under the fluoroscope or by portable *x*-ray before the cast is applied. Rotation of the limb is checked by drawing a tape or narrow piece of bandage from the anterior superior iliac spine to the cleft between the first and second toes. This line should in most instances bisect the patella. This, however, is compared with the normal limb. Posterior bowing is the most common deformity following reduction, but this can be corrected easily by wedging the cast. If a mechanical device is not available, the reduction may be accomplished by using a fracture table. The patient is placed on the table, the symphysis pubis against the upright perineal bar. The distal pin is fastened to the foot piece and traction is made. The proximal pin is steadied with a pin clamp or attached to the overhead bar on the fracture table. A portable *x*-ray is taken to check on the reduction and to be certain that too much traction has not been applied.

4. Sheet wadding (splint cotton) is placed on the leg from the toes to the upper thigh. A circular plaster of Paris cast is then applied to the leg extending from the toes to the upper thigh, incorporating a thin molded plaster of Paris splint. The plaster is placed snugly around the pins incorporating them firmly in the cast.

5. The limb remains in the apparatus until the cast is hard, usually about fifteen minutes. Ordinary corks are then placed over the sharp ends of the Steinman pins and fastened in position with plaster bandage. After the patient is returned to his bed, the limb is elevated on pillows to overcome the edema.

6. Further check-up *x*-rays may be taken after the plaster is set. If the radiographic studies are satisfactory and the fragments are in good position, a walking iron is incorporated in the cast and the patient is made ambulatory in a few days. To give the patient added height, a shoe, not a slipper, is worn on the well foot, and some weight bearing is then allowed on the fractured limb with the walking iron. These patients are usually ready for discharge in about eight or ten days. Mental, economic and a familial hazards are overcome, and when advised as to early discharge we find that patients are more co-operative. Usually the cast and the pins are removed at the end of six weeks and the amount of motion at the site of fracture is estimated. It may be graded one, two, three or four plus in both anteroposterior and lateral directions. Very rarely union is firm at the sixth week, more frequently it is two plus in both directions. A new cast is now applied extending from the toe to the midthigh at this time. Very little wadding is used, usually a stockinette, with a turn of splint cotton around the ankle, knee and upper thigh. At the end of three weeks, the patient is re-examined. If no motion is present, a circular cast is applied from the knee to the ankle and weight bearing increased. If the amount of motion remains stationary for a period of five to six weeks, the case is considered to be one of delayed

union. A drilling operation is then performed to stimulate callus formation. There is no hard and fast rule as to the length of time it takes a fractured tibia to unite. Except in children, the time varies from eight to twelve weeks. Compound fractures, however, may take as long as sixteen weeks. One case in our series resulted in nonunion because of the loss of a large fragment of bone at the time of injury. This case eventually came to surgery, bony union taking place following a sliding bone inlay operation.

In compound fractures in which double Steinman pins are indicated, they are introduced before the débridement is done. The fracture, however, is not reduced until after the wound has been thoroughly irrigated. Plenty of warm saline, in an irrigating can and not a bulb syringe, is used to flood and wash out the wound properly. Questionable devitalized tissue is removed. The skin edges are always resected, i.e., a thin edge of skin is removed with a scalpel. Those compound fractures operated upon within six hours of injury are closed primarily. The skin only is sutured with interrupted black silk. No drains are used. In our series no sulfanilamide nor prophylactic gas grangrene antitoxin was used. Tetanus antitoxin, 1,500 to 3,000 units, is given intramuscularly. While we give tetanus antitoxin routinely, we no longer advocate prophylactic gas antitoxin.

Since we have been treating our compound fractures by the double pin method, débridement and plaster encasement, we have not observed any gas bacillus infection. We are convinced that complete rest of the wound in plaster of Paris prevents further irritation to already injured tissues. In December, 1940, we reported results obtained in a series of eighty-five consecutive cases of compound fractures. Forty-three of these were treated by primary immediate closure of the wound. Two of these patients developed infections. One patient not infected died. Sulfanilamide, by mouth was used in only one case.

Since September, 1937, we have treated eighty-nine patients by the double pin method at the Flower-Fifth Avenue Hospitals and the Metropolitan Hospital, New York City. We believe that the results have been uniformly good. There has been no case of pin infection. The ambulatory treatment has not interfered with the fracture healing and yet has markedly reduced the cost of hospitalization.

At this time of national hysteria, when methods for the management of civilian casualties are to be considered, this method for handling slipping fractures of the tibia and fibula offers a timely solution. It is simple and rapid in execution. The patients are made ambulatory early and the hospitalization time is short.

SUMMARY

In fractures of the tibia and fibula with displacement, and those that have a tendency toward displacement, the double pin method is indicated. The advantages of this method are: (1) uniformity of procedure; (2) no operative team is necessary. Elaborate technic for reduction of fracture is done away with. (3) In our series, there has been no case of infection at the site of the Steinman pins. (4) Inasmuch as this method produces firm fixation, it has a particular advantage in the treatment of compound fractures. (5) The time and cost of hospitalization have been drastically reduced as compared with previous methods employed. (6) With the use of the double pin method we obtain firm immobilization of the fractured fragments as compared to the previous method of skeletal traction—suspension with one pin through the os calcis.

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MEDIASTINAL EMPHYSEMA AND PNEUMOTHORAX FOLLOWING TRACHEOTOMY FOR CROUP*

J. D. GOLDBERG, M.D.,
First Lieutenant, Medical Corps, U. S. Army

N. MITCHELL, M.D.
Resident in Pathology, Queens General Hospital

AND

A. ANGRIST, M.D.
Pathologist, Queens General Hospital

JAMAICA, LONG ISLAND, N. Y.

INTRODUCTION

MEDIASTINAL emphysema and pneumothorax have been considered rare complications following tracheotomy in croup cases. In a series at the Queens General Hospital, both complications have been seen frequently. Many of the patients with complications present few or no symptoms and probably would have remained unrecognized without routine postoperative *x*-rays. Some, however, are followed by the well known respiratory and cardiovascular repercussions of pneumothorax, with an occasional fatal outcome.

The route of entry of air into the mediastinum and pleural cavities has been the subject of much debate. An evaluation of all possible mechanisms and the demonstration of the most frequent pathway in this group of cases will be attempted.

LITERATURE

Michels[5] has reviewed the literature recently, so that only a few references will be cited. Champney[1] performed tracheotomies on stillborn infants and then subjected them to artificial respiration with the tracheotomy opening partially obstructed. He noted that mediastinal emphysema occurred in all cases, and pneumothorax was listed as a frequent finding. Kies[2] cited one case of massive mediastinal emphysema with bilateral pneumothorax, following thyroidectomy. He injected air into the mediastinum through the sternum or jugular notch in two cadavers, and noted the development of mediastinal emphysema followed by pneumothorax. Macklin[3] produced mediastinal emphysema in cats by overinflation of their lungs under high pressures. He concluded that the air ruptured through the alveolar wall and dissected back to the mediastinum by way of the perivascular lymphatics. Further injection of air led to rupture through the mediastinal pleura, with the production of pneumothorax, often bilateral. The visceral pleura consistently remained intact. He found it impossible to produce mediastinal emphysema by the injection of air directly into the pleural cavity, even though extremely high pressures were used. Simpson[4] reported a case of pneumothorax following tracheotomy and referred to the rarity of such a complication. Michels[5] added six case reports. He discussed possible mechanisms for the production of pneumothorax and suggested bronchoscopy prior to tracheotomy as a means of prevention. Barrie[6] described four fatal cases of pneumothorax following operations on the neck. Three followed thyroidectomy, and the fourth, tracheotomy for glottic edema. All were associated with mediastinal emphysema. He postulated the route of entry of the air to be through the operative wound into the mediastinum, thence into the pleural cavities. He demonstrated an intact cervical pleural dome in each instance by methylene blue installation into the pleural sac.

ANATOMY

The accompanying diagrams indicate schematically all possible routes for the

* From the Departments of Pathology and Pediatrics, Queens General Hospital, Jamaica, New York.

entrance of the air into the mediastinum and pleural cavities involved in cases of obstructive breathing. (Figs. 1 and 2.)

showed only limited mediastinal emphysema and no pneumothorax. (Fig. 3.)

Case II. *Mediastinal emphysema and pneumothorax causing no symptoms:* J. W., a fifteen-month old white male, was admitted on January 3, 1940, with mildly obstructive respiration. A diagnosis of croup was made and conservative therapy instituted. By the next day, the respiratory difficulty had increased. Laryngoscopic examination revealed subglottic edema, and intubation was done with marked relief. On January 10, 1940, extubation led to immediate recurrence of symptoms. Because the patient repeatedly coughed up the tube, a tracheotomy was done on January 12, 1940. The patient remained comfortable after that procedure. Chest *x*-ray taken on January 13, 1940 revealed mediastinal emphysema, 70 per cent pneumothorax on the right, and minimal pneumothorax on the

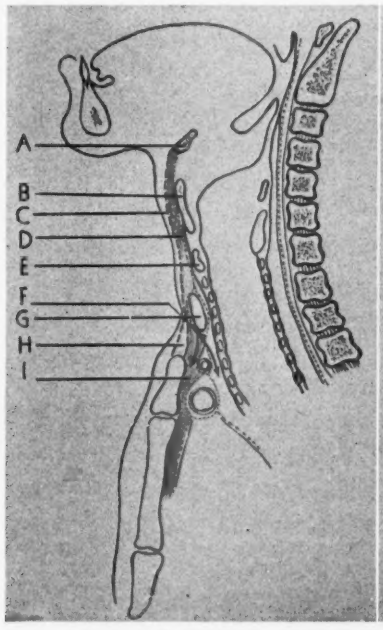

Fig. 1.

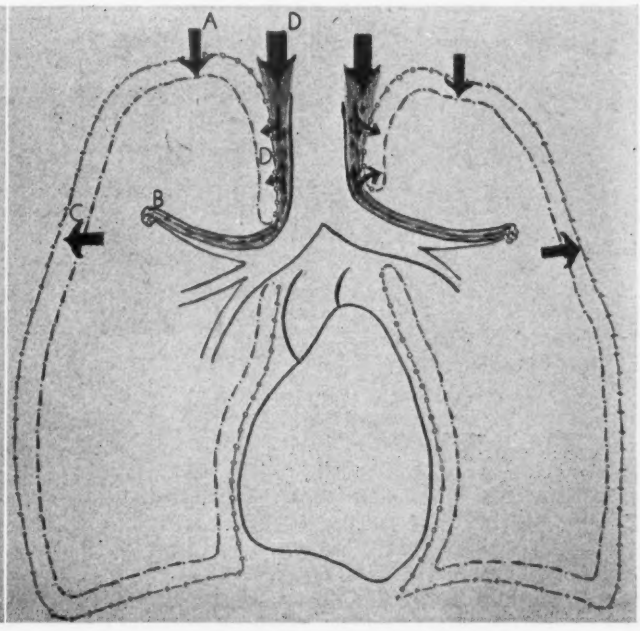

Fig. 2.

Fig. 1. Cervical fascia, demonstrating pathway of extension of air from neck into mediastinum. (Modified after Davis, Applied Anatomy, Figure 180.) A, Hyoid bone; B, thyroid cartilage; C, superficial leaflet of deep cervical fascia; D, deep leaflet of deep cervical fascia; E, cricoid cartilage; F, tracheotomy site; G, thyroid gland; H, space of burns; I, anterior mediastinum.

---------Superficial leaflet of deep cervical fascia.

.....Pretracheal (deep) leaflet of cervical fascia.

Fig. 2. Possible pathways of extension of air into pleural cavities and mediastinum. A, injury to apical pleura; B, rupture of alveolus with extension to mediastinum and rupture of mediastinal pleura; C, rupture of visceral pleura; D, extension of air through tracheotomy wound between superficial and deep leaflets of deep cervical fascia into mediastinum with rupture of mediastinal pleura (usual mechanism).

–+–+Parietal pleura.

–·–·–Visceral pleura.

–0–0–Mediastinal pleura.

The variations in the route of entry of air, and in the symptomatology are illustrated by the following case histories:

Case I. *Mediastinal emphysema causing no symptoms:* D. G., a two-year old white female, was admitted on March 4, 1940, with a twelve-hour history of respiratory difficulty following an upper respiratory infection of seven days' duration. Examination revealed a restless, pale child, breathing with inspiratory stridor. Moderately deep supraclavicular and sternal retractions were present. On laryngoscopy, a marked supraglottic edema was evident. Immediate tracheotomy was performed with instantaneous and permanent relief. Check-up *x*-ray on March 6, 1940

left. A repeat *x*-ray on January 29, 1940 showed complete absorption of air from the mediastinum andno evidence of pneumothorax.

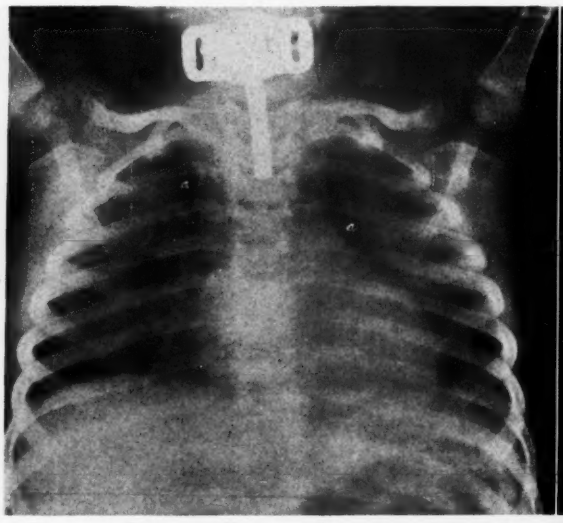

FIG. 3. Case I. *X*-ray taken two days after tracheotomy showing air limited to mediastinum (*a*). Lateral view shows similar substernal localization of air.

retropharyngeal swelling. Despite chemotherapy, the swelling progressed to such an extent by the next day, that the child showed obvious

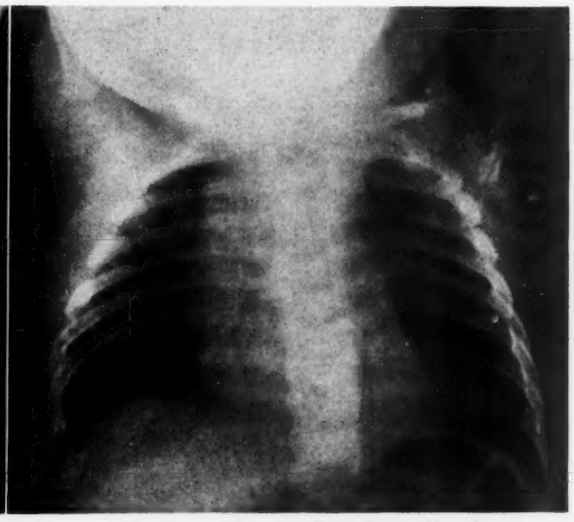

FIG. 4. Case IV. *X*-ray taken immediately preoperatively showing absence of air in mediastinum or pleural cavities.

CASE III. *Pneumothorax following injury to cervical pleura, causing respiratory distress, but not requiring intervention:* P. D., a fourteen-month old white female, was admitted on March 18, 1940 with a twenty-four hour history of progressive respiratory difficulty and a croupy cough. Trial intubation gave no relief. The child's condition grew worse rapidly, with increasing cyanosis and dyspnea. A long metal suction tube was passed through the larynx to provide an airway and an emergency tracheotomy was done. During the procedure, the pleura was seen to bulge high into the wound and the right pleural dome was injured, producing an audible hiss. The operative procedure was completed without further examination or repair of the pleura. Physical examination immediately postoperatively showed signs of a partial pneumothorax on the right. The child was perfectly comfortable at this time. By the next day the respirations had risen from thirty to eighty per minute. *X*-ray at this juncture revealed 80 per cent pneumothorax on the right. *No mediastinal emphysema was present.* The child improved rapidly and made an uneventful recovery.

CASE IV. *Mediastinal emphysema and pneumothorax requiring intervention:* C. J., a three-month old white female, was admitted on December 12, 1940, with right otorrhea and a respiratory distress. The swelling was incised but no pus was encountered. Following this, the obstruction to breathing progressed so rapidly that an emergency tracheotomy was necessary five hours later. (Fig. 4.) After exposure of the fascial planes of the neck, a technical difficulty caused considerable delay before incision into the trachea. During this interval, air could be heard *being aspirated through the wound edges* by the forceful inspirations of the infant. Immediate relief was apparent on completion of the tracheotomy. Two hours postoperatively, it was noted that the child was becoming increasingly more dyspneic. The respirations were definitely not of the obstructive type. Physical examination suggested bilateral pneumothorax. A peculiar crepitant sound was heard over the sternum, synchronous with each heart beat. An emergency *x*-ray (Fig. 5) revealed bilateral pneumothorax, almost complete on the left, and moderate mediastinal emphysema. Immediate partial relief was seen after the removal of 50 cc. of air under positive pressure from the left chest. Four hours later, it was necessary to again tap the left chest, with removal of about 60 cc. of air. On this occasion, the air was under negative pressure, and aspiration by syringe was necessary. Improvement thereafter was rapid. *X*-ray two weeks later revealed

only a slight degree of mediastinal emphysema and no pneumothorax.

Case v. *Mediastinal emphysema and pneumothorax with fatal termination:* A. K., a four-year old white female, was admitted at 1 A.M. on March 5, 1940 with a twenty-four hour history of a croupy cough and dyspnea. The patient was severely ill, presenting marked cyanosis and deep supraclavicular and sternal retractions. Direct laryngoscopy revealed marked edema and redness of the larynx. Intubation was performed with only slight relief, so that tracheotomy was resorted to at noon. Immediate temporary improvement followed, but cyanosis and dyspnea soon recurred and rapidly grew worse. At 2 P.M. the patient was bronchoscoped through the tracheotomy wound. No relief from this procedure was evident. Chest *x*-rays taken at 3:30 P.M. revealed 60 per cent collapse of the right side and 70 per cent of the left, with "pancaking of the lung." Slight improvement was noted after aspiration of 250 cc. of air under positive pressure from the right pleural cavity, and 75 cc. from the left. One hour later, 200 cc. was aspirated from the right side and continuous decompression was started by connecting the needle with a rubber tubing placed under water. No air, however, escaped from the tubing. The child died during this procedure.

Postmortem examination revealed an extensive mediastinal emphysema and a right tension pneumothorax. Although air under positive pressure was not found in the left pleural cavity, a partial collapse of the left lung is correlated with the *x*-ray findings of left

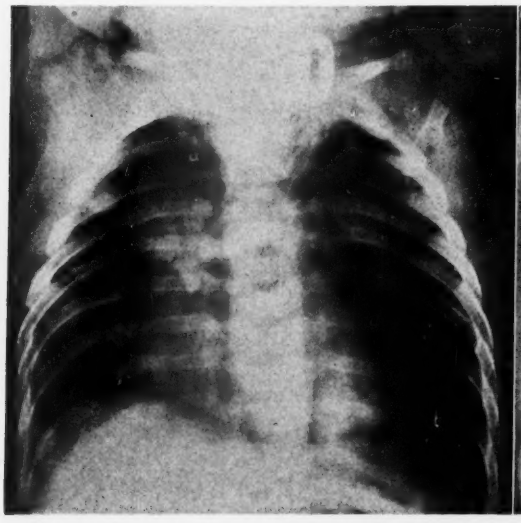

Fig. 5. Case iv. *X*-ray taken two hours after tracheotomy showing bilateral pneumothorax (*b*) and mediastinal emphysema (*a*), the latter confirmed by lateral view.

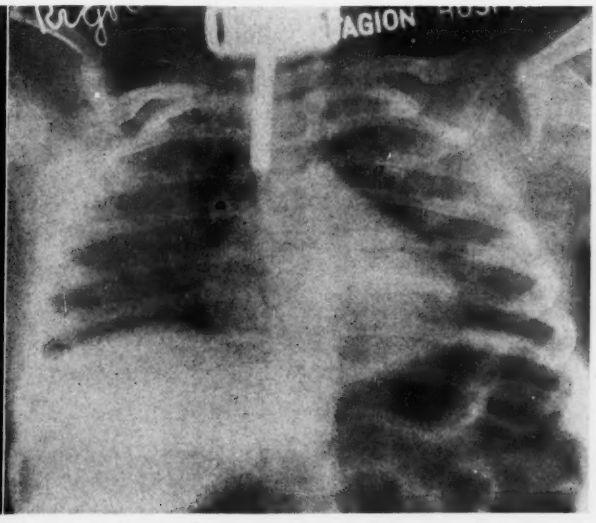

Fig. 6. *X*-ray taken several hours after tracheotomy, showing massive mediastinal emphysema with considerable quantity of air following contour of mediastinum (*a*).

pneumothorax. The usual method of demonstrating pneumothorax at autopsy by opening into the pleural cavity under water and watching for the escape of air, will demonstrate only positive tension pneumothoraces. A negative tension pneumothorax may exist as in Case iv, because of the shift of a labile mediastinum.

Case vi. *Mediastinal emphysema in a case of trauma demonstrating the pathway of air by way of the cervical fascia:* C. H., a twenty-year old white male, was injured while riding on a motorcycle. He was brought to the hospital in a comatose state. Respirations were rapid and labored. Multiple fractures of the bones of the face were observed. There was a large perforation through the buccal mucosa in the floor of the mouth near the frenulum. No other lacerations in the skin of the neck were present. Death occurred two hours after admission.

Autopsy disclosed marked mediastinal emphysema. Pneumothorax was not demonstrated. No rib fractures were present. Definite air bubbles were found beneath the superficial leaflet of the deep cervical fascia. The air had evidently been aspirated through the lacerated buccal mucosa. From this source, the air could dissect beneath the superficial leaflet of the deep cervical fascia only if a fracture of the hyoid bone were present. On this basis, the neck organs were investigated, and multiple

fractures through the body and greater cornua of the hyoid bone were found. It is our impression that this confirms the essential mechanism by which mediastinal emphysema and pneumothorax are produced following tracheotomy for croup.

COMMENT

Pneumothorax can be produced by any of the mechanisms indicated in Figure 1. In Case III, the air obviously entered the pleural cavity through a traumatic perforation of the apical pleura incurred at the time of operation. (Route *A*.) In the described instance, it must be remembered that the pneumothorax was unilateral and that there was no mediastinal emphysema.

Mediastinal emphysema was demonstrated by routine postoperative *x*-rays on twelve occasions in a series of eighteen tracheotomies on patients with croup. The observations extended over a period from November, 1939, to January, 1941. There were eight cases of pneumothorax, three of which were bilateral. *In all cases in which there was pneumothorax, there was a coexistent mediastinal emphysema.* The only exception is represented by Case III, in which the apical pleura was injured.

If trauma to the apical pleura were the usual mechanism for the production of pneumothorax, the coincidental mediastinal emphysema found in such cases would remain unexplained. To explain the high incidence of bilateral pneumothorax, one would have to postulate further that both pleural domes were injured. It is more reasonable to assume that the association of mediastinal emphysema and pneumothorax is more than coincidental. The frequent occurrence of mediastinal emphysema without pneumothorax, and the rarity of pneumothorax without mediastinal emphysema, strongly suggests that the presence of air in the mediastinum is essential for the production of pneumothorax. Weight to this supposition is added by Macklin's work showing that it was impossible for air under positive pressure to penetrate the mediastinum from the pleural cavity, but that the opposite route was quite feasible experimentally.

How then does the air reach the mediastinum? If it were by rupture of an alveolus (Route *B*), with escape of air along the peribronchial and perivascular lymphatics incident to the high negative pressures developed during obstructive breathing, mediastinal emphysema should be more common *before* tracheotomy. If rupture of the alveolus occurred during the sudden inrush of air following relief of the obstruction, mediastinal emphysema should be as common *following intubation* as it is following tracheotomy. *X*-rays before tracheotomy failed to reveal mediastinal emphysema or pneumothorax. This negative finding would seem to make the rupture of an alveolus a less likely mechanism.

If rupture of the visceral pleura (Route *C*) were the cause of pneumothorax, the co-existence of mediastinal emphysema would still remain unexplained. The analysis outlined above, eliminating alveolar rupture, applies as well to rupture of the visceral pleura as the usual mechanism.

With these clinical data in mind, the following experiments were undertaken to demonstrate the probable route of entry of air into the mediastinum and pleural cavities.

EXPERIMENTAL DATA

Nine cadavers ranging in age from a stillbirth of six months' gestation to a one-year old infant were employed. All procedures were performed with the cadaver under water, so that any leakage of air was instantly demonstrated.

Experiment A. A longitudinal incision was made through the skin from the symphysis mentis to the upper abdomen and the skin reflected laterally. The subcutaneous fat and muscles were removed with the skin flap over the thorax. The costal cartilages were divided close to the sternum and the ribs retracted so as to visualize the mediastinal structures. The fascial planes of the neck were then identified by sharp dissection. A No. 20 needle

was inserted beneath the superficial leaflet of the deep cervical fascia. Air was injected under positive pressure. The pressure was measured by a mercury manometer connected with the needle through a side-arm.

Results. Injection of air under pressures of 15 to 20 mm. of mercury beneath the superficial leaflet of the deep cervical fascia resulted in a dissection of the air down along the fascial planes into the anterior mediastinum. Large emphysematous blebs formed in the mediastinal tissues under direct observation. After injection of 20 to 50 cc. of air, no more air could enter the mediastinum unless the pressure was raised considerably. At a pressure of approximately 40 mm. of mercury there was a rapid fall to zero. Observation of the mediastinum invariably revealed a simultaneous rupture of an emphysematous bleb into the pleural cavity. The usual site was at the left inferolateral border of the thymus gland. More air could now be injected readily *at much lower pressures*, ranging from 0 to 5 mm. of mercury. It is significant that a slight change in the position of the cadaver was sufficient to close off this original rupture site. Whenever this occurred, the positive pressure rose to 40 mm. of mercury again, before another site of rupture could be seen. The new site was frequently on the opposite side of the mediastinum. In no case could air be identified beneath the endothoracic fascia.

Experiment B. Both lungs were removed with a block of mediastinal tissue. Air was injected into both main bronchi under pressure.

Results. Injection of air into the main bronchus resulted in inflation of the lung until no more air could be accommodated without a rise in pressure. In some cases, small bubbles of air could be seen in the subpleural lymphatics, demonstrating a possible mechanism for extension to the mediastinum. The pressure then rose rapidly to levels of 65 to 70 mm. of mercury, at which point rupture occurred, usually through the mediastinal pleura at the hilum.

Occasionally, a point of rupture was identified in the visceral pleura. Usually, local pathological conditions such as pneumonitis could then be demonstrated.

COMMENT

It is true that the experimental conditions of forcing air into the mediastinum under positive pressures are not duplicated exactly in a case of croup. However, an equivalent situation does exist. During the powerful inspiratory movements of croup, high negative intrathoracic pressures are developed, and serve to draw air into the lungs through the partially obstructed natural airway. With incision of the cervical fascia incident to tracheotomy, an initial pathway is established for aspiration of air through the wound edges into the mediastinum. On forced expiration, positive pressures are developed within the chest. The superior aperture to the mediastinum, which is widest during inspiration, is now at its narrowest diameter and tends to trap the mediastinal air. The positive pressure then forces the trapped air further down along the tissue planes. When appropriate pressure levels are reached for each individual case, rupture through the mediastinal pleura into the relatively unsupported pleural space occurs, with the production of pneumothorax. (Route *D.*) Rupture may occur on one side only. Now if this first route is temporarily obstructed by change in position of the patient, corresponding to the experimental observations, a new point of rupture may appear on the same or opposite side. *Once this fistulous tract is established*, which must happen while the patient is struggling for air, the usual intrathoracic pressures during ordinary unobstructed breathing will suffice to aspirate additional air into the pleural cavity. This accounts for the progression of the pneumothorax after the tracheotomy is completed. Thus, the usual latent period of one or more hours before the appearance of cyanosis and marked dyspnea is not surprising.

The measures for the prevention of mediastinal emphysema and pneumothorax are apparent, if the mechanism discussed above holds true. If the obstruction to breathing can be relieved by passage of a Mosher tube, or preferably a bronchoscope, as first suggested by Michels, the patient's respirations immediately become less labored. The high negative pressures essential for the production of mediastinal emphysema can no longer occur. However, if such prophylactic procedures are not feasible, it is advisable to reduce to a minimum, the interval between the division of the cervical fascia and the insertion of the tracheotomy tube.

The treatment of the complications of tracheotomy in patients with croup limits itself to the treatment of pneumothorax. In our experience, mediastinal emphysema of itself, has never caused symptoms severe enough to warrant intervention. Absorption of air in these instances occurs spontaneously over a period of days or weeks. In those cases of pneumothorax in which respiratory distress is a prominent feature, simple aspiration of air is usually sufficient to give relief. When the pneumothorax quickly reforms, continuous decompression by connecting the needle to a tube placed under water may be attempted. It must be remembered, however, that only air from positive tension pneumothoraces will be removed by this means. If the pneumothorax is under negative pressure, as in Case IV, the air must then be actively withdrawn.

SUMMARY

1. Routine postoperative *x*-rays following tracheotomy showed mediastinal emphysema in twelve of eighteen cases. In eight, pneumothorax was also present.

2. The route of entry of air into the mediastinum and pleural cavities is discussed and the most frequent mechanism is indicated.

3. The means of prevention of the complications of mediastinal emphysema and pneumothorax are presented.

The authors express grateful appreciation to Dr. Henry Reisman for use of the clinical material and to Dr. Richard Grimes for permission to include the report of Case VI.

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USE AND ABUSE OF IODINE IN THE MANAGEMENT OF GOITER*

JAMES W. HENDRICK, M.D.
Attending Surgeon, Northwest Texas and St. Anthony's Hospitals
AMARILLO, TEXAS

ABOUT the year 1200, Roger von Salerno discovered that the administration of ground sponges and seaweed benefited some of his patients afflicted with goiter. This type of treatment for goiter persisted through the ages, but it was not until 1812 that Condiet[1] ascertained that iodine is the active principle of the sponges and seaweed. In 1863, Trousseau,[2] by mistake, gave a patient suffering from a severe exophthalmic goiter fifteen to twenty drops of iodine daily in place of digitalis. After a fortnight's treatment with iodine, there was a marked clinical remission. The pulse rate was reduced from 150 to less than 90 beats per minute; the patient was less nervous, and had a sense of well being. When the mistake was discovered and the iodine was replaced with digitalis, the symptoms immediately reappeared and the patient could not be adequately controlled again. Condiet[3] had advised against the indiscriminate use of iodine in all cases of goiter.

In 1896, Baumann,[4] experimenting with animals, demonstrated that iodine is normally present in the thyroid gland; later, he and Oswald[5] showed that iodine is contained in the colloid of the follicles. When there was a deficiency of iodine in the animal's diet or water, a hyperplastic goiter developed. When iodine in sufficient amounts was administered to an animal with a hyperplastic goiter, the follicles became distended with colloid and a colloid goiter resulted. Baumann[4] and Oswald[5] had the impression that a colloid goiter is in a resting state and represents a hyperplastic gland's nearest approach to normal, not only as to histological appearance but also chemical composition. They showed that a hyperplastic goiter contains the least iodine, a colloid goiter more, and a normal gland the most. Oswald[6] demonstrated that the active principle of the thyroid is contained in a globulin, which he called thyroglobulin, and that the thyroid of animals in endemic goiter areas contains less iodine than the thyroid of those in non-endemic areas.

In 1907, Marine[7] published the results of his studies on the physiology, anatomy and pathology of the thyroid gland. Later, Marine[8] and Williams continued the work of Baumann and Oswald. At this time, Kocher[9] repeatedly warned against the general use of iodine for all patients with goiter. To quote Boothby,[10] "We are indebted to Kocher for first extensively collecting and presenting the evidence that the indiscriminate use of iodine to patients having goiter is attended with danger." Kocher found it inadvisable to give iodine to patients having a hard, nodular, "meaty" type of endemic goiter, which we know today as nontoxic adenomatous goiter. He found that iodine produced toxicity in this type of goiter.

Kendall,[11] in 1914, isolated the crystalline iodine containing the active principle of the thyroid, which he called thyroxin. This substance has been shown repeatedly to have all the active physiological properties of dessicated thyroid extract. Thyroxin contains about 65 per cent iodine. The body uses about ⅓ mg. of thyroxin daily, and it is estimated that there are about 12 to 14 mg. grams of thyroxin in the body at one time.

* Read before the American Association for the Study of Goiter, Boston, Massachusetts, May 12–14, 1941.

THYROID AND PREGNANCY

The functional state of the thyroid should be determined before any medication is administered. There is an extra demand placed on the thyroid during pregnancy; however, this condition is frequently evidenced by the varying degrees of hyperplasia and hypertrophy which develop. Comparable to this is the hyperplasia which develops in the adolescent individual living in an endemic area when there is a deficiency of iodine. If the pregnant individual lives in an endemic area and her basal metabolic rate is normal, it is well to administer 10 to 20 drops of Lugol's solution weekly. This should prevent goiter in the mother and cretinism or hypothyroidism in the offspring. Breitner[12] states that after five generations of colloid goiter, we may expect to find deaf mutism and idiocy. This should suggest that the expectant mother who has a colloid goiter or evidence of a hypothyroid condition should receive appropriate treatment in order to prevent the child from being hypothyroid at birth. An associate's case clearly shows this. He had under his care three children who exhibited many of the clinical signs of hypothyroidism; such as, mental and physical retardation, broad, spade-like hands, short little fingers, fat bellies with umbilical hernias, dry skin, coarse thin hair, large thick tongues, drolling saliva and delayed ossification of the wrist bones. The mother of these children had a large colloid goiter with a basal metabolic rate of minus thirty-two. During the next pregnancy, she was given thyroid therapy. The baby was born normal in every respect. Later, she moved to another region. She became pregnant again, received no thyroid treatment, and delivered a very definite cretenoid.

NONTOXIC DIFFUSE OR SIMPLE COLLOID GOITER

This type of goiter is prevalent in the endemic areas of the world, but sporadic cases are frequently noted. It develops before or during the adolescent period but may appear in the late teens or during pregnancy. As a rule, it disappears before the twenty-fifth year. In the absence of an adequate supply of iodine, the physiology of the thyroid is disturbed, and a deficient amount of thyroxin is delivered to the tissues, causing hypothyroidism. This altered physiology stimulates the thyroid, and hyperplasia and hypertrophy result. A decreased amount of colloid is seen in the early stage of this form of goiter. The thyroid is diffusely enlarged, smooth, and elastic, and no nodulations are felt. The vascularity is not increased, as there is an absence of thrills, pulsations or bruits. In 1917, Marine[13] and Kimball, working with the school children in Akron, Ohio, demonstrated that this type of goiter could be practically controlled by administering 2 Gm. of sodium iodide twice a year. The iodine was given over a period of two weeks each spring and fall. Later, they suggested that 10 mg. of sodium iodide be administered each week throughout the year, as this would give a more even distribution of the iodine and prevent an overdose. Klinger[14] of Zurich, Switzerland, adopted a similar method of control in that great endemic area. He incorporated the 10 mg. of iodine in a chocolate tablet and called it "Idostarine." The tablet is stable and more pleasant for children to take. McClure[15] of Detroit detailed before this association the results of the use of iodized table salt in Detroit from 1924 to 1937. Iodized table salt contains .01 per cent of sodium iodide. The average consumption of salt per individual is about eight pounds annually, which gives him about 1 mg. of sodium iodide daily. In 1924, the incidence of simple goiter among the school children of Detroit was 35 per cent. In 1936, or twelve years later, the incidence of simple colloid goiter was 2.6 per cent.

When a colloid goiter is present in the late teens or in early adulthood, the administration of too much iodine must be carefully avoided. This fact was stressed in 1907 by Kocher[7] and again in 1925 by

Plummer,[16] both of whom noted that large doses of iodine induced activation. Most of the colloid goiters we have seen showed definite evidence of hypothyroidism, namely, dry skins, listlessness, and basal metabolic rates below the average normal, usually minus fifteen or twenty. In the large goiters, thrills, bruits and pulsations are often noted over the superior thyroid arteries. Dessicated thyroid extract has proved of value in treating these patients; younger individuals require ½ or 1 gr. daily, and older individuals, with large colloid goiters, 1 to 2 gr. The pulsations and bruits disappear as the gland shrinks. These cases must be constantly observed for any signs of activation. After two or three months, the gland has shrunk enough to permit the detection of any adenomas. If adenomas are not present, the patient should be given Lugol's solution, 10 drops twice a week, along with the thyroid extract. This treatment is a prolonged one, and it may be stated that the older the individual the more unsatisfactory the treatment. When iodine is indiscriminately used over long periods of time in colloid goiter, symptoms of hyperactivity may appear, and the inactive gland is converted into the active hyperplastic type, as Goetsch[17] has shown.

NONTOXIC ADENOMA

Any nodular enlargement of the thyroid is presumed to be adenomatous. There are two general types of adenomas: The fetal type is a true tumor of the thyroid gland, having its origin, according to most investigators, in the interacinar cell remnants of Wolffler. In the earliest stages of the fetal adenoma, the tissues simulate those of a four or five month fetus. The acini are poorly developed and there is an absence of colloid material. The adenoma, being encapsulated, is free from periodic cycles of hyperplasia and involution, which are common to the normal gland.

Colloid adenomas are by far the most frequent type; these are found throughout the world, although more frequently in endemic areas. The readily discernible enlargement is produced by multiple growths throughout both lobes and the isthmus. Plummer[16] states that this type of goiter always has its inception in the colloid goiter. Reinhoff[18] is of the opinion that they are "involutional bodies," areas of tissue which have regressed or failed to regress during hyperplasia and involution. Still others contend that they are produced by the indiscriminate use of iodine in colloid goiters. There is very definite clinical evidence to the effect that iodine, especially in large doses, activates this form of goiter. Plummer and Jackson[19] advised against its use, especially in older patients. Very toxic adenomatous goiters are found in individuals under thirty years of age who had no symptoms of toxicity until they began taking iodine in varying amounts over a period of a few weeks to several months. McClure[20] states that after the introduction of iodized salt in Detroit (in 1924), there was (in 1927) a gradually increasing number of goiter patients coming to operation, in spite of, or perhaps because of, the introduction of iodized salt. The majority of the cases were of the nodular toxic type. Also in 1927, the death rate from goiter in Detroit reached its peak. In 1926, Hartsook[21] had reported that many individuals with nontoxic goiters were precipitated into activity by iodine. Later, McClure reported that the number of goiter operations had gradually declined in Detroit, since the incidence of colloid goiter decreased from 35 per cent in 1926 to 2.6 per cent in 1927. As stated above, Plummer[27] demonstrated that adenomas have their inception in colloid goiters. This type of goiter, once present, does not disappear; it tends to become toxic in later years, and malignant degeneration takes place in 6 to 8 per cent of the cases. It is, therefore, strictly a surgical condition and can be removed safely with practically no risk. If not removed, its course is constant and progressive, and, as Hertzler[22] affirms, "This type of goiter kills the patient unless

some intercurrent disease anticipates this end." Iodine should not be used for treatment and is not necessary in preoperative preparation.

TOXIC NODULAR OR ADENOMATOUS GOITER

The evidence of toxicity in this type of goiter develops gradually. The patient is not incapacitated for many years after the appearance of the goiter, unless the toxicity is induced by the indiscriminate use of iodine. The cardiovascular system receives the brunt of the thyrotoxicosis or toxemia. The symptoms of hyperthyroidism are often very mild, while the cardiac symptoms predominate, and little thought is given the adenoma as the causative factor.

There are two general theories regarding the toxicity in adenomatous goiter: Plummer[30] thought it was a pure hyperthyroidism, such as could be produced by the administration of dessicated thyroid extract, or thyroxin. The thyroid gland normally produces about ⅓ mg. thyroxin daily. If the adenoma is quiescent and does not produce any thyroxin, no symptoms of toxicity develop; if the adenoma becomes active and produces as much as ⅓ mg. of thyroxin daily and the thyroid rests, there still are no symptoms, but if the adenoma and thyroid are both active, toxicity ensues. Plummer also thought that as the adenomatous tissue becomes active it stimulates the surrounding tissue to hyperfunction.

Hertzler[23] and Chesky[24] have produced evidence to the effect that in a number of older patients with adenomatous goiter, all symptoms cannot be ascribed to a pure hyperthyroidism as produced by hyperplasia and hypersecretion. They contend that the toxemia is due to some change in the chemistry of the colloid. Early in the life of a colloid goiter, there is a gradual degenerative change in the colloid which produces an abnormal colloid having a deleterious effect on the heart, and can occur independently of any epithelial hyperplasia or simultaneously with it, resulting in toxemia of degeneration, as well as hyperplasia.

We have noted that when toxicity develops in younger patients with adenomatous goiter, it simulates a true hyperthyroidism, in which the pulse rate is faster and the basal metabolic rate is higher than in older patients. It is remarkable how rapidly the cardiovascular system returns to normal following the enucleation of the adenomatous tissue. Toxic adenomatous goiters, as a group, do not respond to the preoperative administration of iodine in the same ratio as the exophthalmic group. Goetsch[25] stated that his results after the adoption of preoperative administration of iodine were no better than they were before; he ascribed this to the indiscriminate use of iodine in recent years. He continued to give iodine, however, and observed that the cases in which symptoms appeared only after taking iodine, or which were activated by it, were the most difficult to control. Goetsch is of the opinion that in such cases the iodine should be replaced by sedatives for one or two months, after which iodine may be given intensively for two to four weeks before surgical correction.

We have had the most favorable response in the younger group of patients who exhibit marked hyperactivity, with little or no degeneration in the gland, and with areas of hyperplasia, and who have not taken iodine previously. The majority of such cases have a reduction in the pulse and basal metabolic rates after the administration of 15 drops of Lugol's solution three times daily for two weeks. We have observed that the more hyperplasia there is present, the better the response to preoperative iodine medication.

Several observers have noted that a certain percentage of cases do not respond favorably to preoperative iodine medication. Lerman[26] found that patients over fifty years of age do not exhibit the same clinical remission to preoperative iodine medication as patients under that age. In a group of 706 patients, 96.6 per cent showed a favorable response, with an operative

mortality of 1.4 per cent, whereas in the 3.4 per cent which showed no response, there was a mortality of 24 per cent. The latter group of patients should have stage operations, the removal of the two lobes being separated by a rest of four to six weeks. Pole ligations are of no value in this type of goiter, as the superior thyroid vessels are not enlarged as compared to the exophthalmic type.

DIFFUSE TOXIC OR EXOPHTHALMIC GOITER AND IODINE

As mentioned above, Trousseau, in 1863, administered iodine, by mistake, in place of digitalis, to a patient with exophthalmic goiter, and noted beneficial results. Marine,[7] in 1907, observed that when iodine is given to a patient with a hyperplastic goiter, the follicles become distended with colloid and the gland enters a resting stage. Plummer was of the opinion that Grave's disease is evidently a dysthyroidism, and that the secretion is qualitatively abnormal, and excessive in amount. The normal hormone, thyroxin, is incompletely iodized, and the incomplete thyroxin, as it leaves the gland, enters catabolic reaction faster than the normal stable molecule and, therefore, raises the metabolic rate more rapidly. Administration of iodine changes the character of the molecule and iodizes it, rendering it normal, thereby reducing the metabolic rate and clinical symptoms. In 1923, Plummer[27] instituted the program of preoperative administration of 10 drops of Lugol's solution three times daily, with remarkable results. Within seven to fourteen days, in most cases, there was a marked clinical remission. There was also an immediate lowering of the operative mortality, with fewer postoperative crises and complications. This form of preoperative management was soon adopted by surgeons throughout the world. It was further shown by Plummer that the clinical remission would last from three to eight weeks. When the condition was not corrected surgically, the symptoms would return to their former severity or become worse, even if Lugol's solution were given to tolerance. The patient is then robbed of his chance to be taken safely through an operation, for he is then "iodine fast."

All students of goiter agree that no frank case of hyperthyroidism is ever cured with iodine. It should be explained very carefully to the patient with an exophthalmic goiter that his case is surgical and that Lugol's solution is only used to prepare him for a safe operation. We never, under any consideration, prescribe Lugol's solution for a patient, unless the latter and his family understand that the drug is used for preoperative treatment, and definite arrangements are made for operation. It is explained to the patient that, as a rule, after a few days of iodine medication, the symptoms will subside or decline, and he may question the necessity of a thyroidectomy; but when improvement has reached a certain point, the surgery must take place.

Every goiter surgeon sees too many patients who have had Lugol's solution or other forms of iodine for months or years, until irreparable damage to the cardiovascular system and the liver has been done. Such patients often require stage operations and prolonged hospitalization in order to prevent excessive mortality. In patients who have had long continuous iodine medication, it is more difficult to evaluate properly the surgical risk. Lahey[28] has stressed this point for several years. When the patient is first seen, a preliminary evaluation of the risk is made; at no other time can this be done so advantageously. After bed rest, diet, sedatives and Lugol's solution, it is almost impossible to judge the proper time for operative interference without knowledge of the original status of the patient.

Mild cases of exophthalmic goiter are frequently encountered. Such cases should be observed until the diagnosis is definite; then they should be prepared with Lugol's solution and the condition corrected surgically. It is very unwise to give them a bottle

of iodine and let the disease progress until marked hyperthyroidism is present with cardiac damage.

Cases of recurrent hyperthyroidism are often found, following subtotal thyroidectomy for exophthalmic goiter. This occurs in about 3 per cent of any large group of cases studied. If the symptoms persist after the primary operation even in a mild form, the condition is termed persistent hyperthyroidism as differentiated from cases which develop symptoms of hyperthyroidism, from one to five years after the initial operation. These cases of recurrent hyperthyroidism can often be controlled by the prolonged administration of small doses of Lugol's solution; this is especially true of the disease in a mild form. Haines,[29] reporting from the Mayo Clinic, found that it is possible to control about 25 per cent of the cases of recurrent hyperthyroidism with prolonged administration of Lugol's solution. If the symptoms are severe and there is a large amount of hyperplastic tissue present, a secondary thyroidectomy will be necessary.

Although much time has been spent on educational work, iodine is one of the most misused drugs in the pharmacopoeia. There persists a too common belief, both among physicians and laity, that, given a goiter, regardless of type or activity, iodine medication must follow in one form or another. It is too often used when not indicated and wrongly used when indicated, with harmful results. It is sold over the counter in pills and ointments and is even advertised.

In order to confirm the impression that iodine is still widely misused, a questionnaire was sent to the members of the American Association for the Study of Goiter. While the author is cognizant of the danger of conclusions from questionnaires, based on broad and equivocal questions, he nevertheless, believes that the answers, particularly to the last questions are illuminating and valuable. Following are the results:

	Per Cent
1. Question: What form of iodine medication do you use in diffuse nontoxic (colloid) goiter?	
Answer: Lugol's solution	50
Idostarine	16
Idostarine and thyroid extract	30
No treatment	4
2. Question: Do you treat mild cases of diffuse toxic (exophthalmic) goiter with iodine or advise surgery?	
Answer: Iodine only	4
Iodine followed by surgery, if necessary	8
Surgery with iodine preparation	88
3. Question: How long after surgery for diffuse toxic (exophthalmic) goiter do you recommend iodine administration?	
Answer: Two weeks after surgery	18
Three months after surgery	20
Six months after surgery	24
One year after surgery	32
4. Question: Are you generally able to control mild recurrent (not persistent) diffuse toxic goiter with iodine medication?	
Answer: No	55
Yes	45
(Seventy-eight per cent of the answers to this question stated that about 70 per cent of the cases of *recurrent* hyperthyroidism must have secondary operations.)	
5. Question: Do you advise iodine medication in nontoxic nodular (adenomatous) goiter in individuals twenty to thirty-five years of age?	
Answer: Yes	1
No (Advise surgery)	99
6. Question: Do you think that iodine medication produces toxicity in nontoxic nodular (adenomatous) goiter?	
Answer: No	21
Yes	79
7. Question:	
(a) What percentage of patients with toxic goiters coming to you for surgery have had previous iodine medication?	
(b) To what extent has this increased the operative risk and mortality?	
Answer:	
(a) Eleven per cent of physicians reported previous iodine medication for 0 to 25 per cent of patients.	
Thirty per cent of physicians reported previous iodine medication for 25 to 50 per cent of patients.	

	Per Cent
	Forty-eight per cent of physicians reported previous iodine medication for 50 to 100 per cent of patients.
(b)	Sixty-eight per cent of physicians report increased risk
	Seventy-eight per cent of physicians report increased morbidity
	Seventy-two per cent of physicians report increased mortality
	Eighty-four per cent of physicians report necessitated stage operations.

SUMMARY

The answers to this questionnaire reveal that 96 per cent of the physicians suggest the use of iodine in the form of Lugol's solution (10 drops weekly) or one 10 mg. idostrone tablet weekly, alone or with dessicated thyroid extract in the treatment of colloid goiter.

Eighty-eight per cent find it necessary to correct mild diffuse (exophthalmic) goiter by subtotal thyroidectomy, and another 8 per cent suggest surgery if the condition is not cured in a reasonable period of time with iodine medication.

The opinion is practically unanimous (99 per cent) that nontoxic nodular (adenomatous) goiter should *not* be treated with iodine medication. As many as 79 per cent of the physicians agree that the promiscuous administration of iodine produces activation or toxicity in this type of goiter.

In toxic goiter, we note the greatest abuse in the use of iodine medication. Almost 90 per cent of the patients treated by goiter surgeons have had previous iodine medication, which produces an increase in the operative risk, and a very definite increase in the morbidity, especially since stage operations are often necessary in order to prevent an increased mortality. Practically all postoperative thyroid crises occur in patients who have had long continued iodine medication before consulting the goiter surgeon.

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Thyroidectomy in animals leads to retardation of growth which bears out a similar finding in children in whom there is a deficient thyroid function. The activity of the growth hormone of the pituitary is not dependent upon the presence of the thyroid but is greater when the thyroid is present. From—"Symptoms in Diagnosis"—by Jonathan Campbell Meakins (Little, Brown and Company).

BURNS AND SCALDS

THEIR ETIOLOGY AND PROGNOSIS

JOHN M. HOFFMAN, M.D.*
Senior Resident, Department of Surgery, Cook County Hospital
CHICAGO, ILLINOIS

Introduction. It is the purpose of this paper to discuss particularly the effect of etiology on the character of a burn, its clinical course and outcome. This study comprises 1,000 consecutive burn cases admitted to the Cook County Hospital between January 1935 and June 1937. Because of our small number of electrical and *x*-ray burns, we have stressed the literature on these types.

A few monographs and papers have been written on the relation of etiology to the prognosis of burns,[13,14,15] but they lie buried in the great mass of papers on therapy.

Classification. Burns have been classified according to penetration,[8] according to body areas involved[1] and according to etiological agents.[3] We shall here only consider the last.

Five etiologic types of burns are recognized: Thermal, light rays, electrical, roentgen ray and radium and chemical.

Etiology. Most burns are of accidental origin. However, in this series there were seventy-nine patients (forty-five colored and twenty-four white) who were deliberately burned. Boiling water was thrown on sleeping persons, dresses were intentionally ignited and chemicals were thrown into faces. They caused four deaths. There were four unsuccessful attempts at suicide by burning.

Predisposing factors which modify the character, course and outcome of a burn case are of five types:

1. *Age:* The average age of these 1,000 patients was twenty-eight years. The very young and the very old have poor tolerance to burns.[13] Infants have a delicate and sensitive skin which reacts violently to even minor noxae. Maintaining them in adequate nutrition is often difficult. The aged are susceptible to the toxemia and the pulmonary and vascular complications of burns.

2. *Sex* plays a rôle. Women suffer more than men. Their dresses constitute a fire hazard, especially in the kitchen.[13] Their death rate was 1.5 per cent higher than that of the male. Pregnancy seems to confer some immunity during the third trimester. Three pregnant women received rather serious burns several weeks before term; they ran a mild course until delivery but all three then became increasingly ill and died within a few weeks postpartum with symptoms of a sepsis lenta.

3. According to Duke,[14] there exists allergy to heat. Certainly some people are burned more easily than others, and Pack[13] holds that skin thickness is not the sole factor. Burns are less serious in the negro and brunette "by virtue of their decreased visceral and sympathetic affection."[13] Our death rate was 11.1 per cent in colored and 14.0 per cent in white patients.

4. *Location:* Burns of the abdomen carry the highest mortality. Out of 110 total deaths the abdomen was involved in forty-six instances, or 41 per cent. Burns of flexor surfaces are more serious than of extensor surfaces. Burns of the genitalia, anterior chest wall and trigeminal area of the face produce most shock. Mucosal burns are more grave than cutaneous burns of equal area.[14]

5. Concomitant infirmities make the prognosis worse. Decreased pain and tactile sense make alcoholics, epileptics, tabetics

* First Lieutenant Medical Corps, United States Army.

and paralytics less sensible of injury. Thirty-five patients were burned in alcoholic stupor; eleven died, or 31 per cent. Of twenty-five epileptics, one died; of four narcotic addicts and eight psychiatric patients, three died. Thus seventy-two patients, or 7.2 per cent of the total, had neural or sensorial lesions, 13.6 per cent of the total deaths.

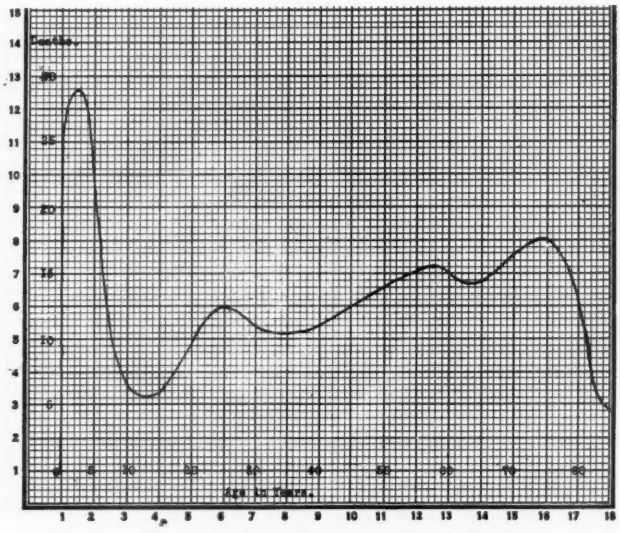

FIG. 1. The relation of age to death in burns.

Burns Due to High (or Low) Temperatures. According to Pack,[13] dry heat above 140°F. is required to produce a burn and moist heat above 125°F. to produce a scald. The better conductors of heat and the heavier liquids produce the more severe contact burns. Mucous membranes and peritoneum (hot laparotomy sponges) are more easily injured than skin.[13]

Flames caused 379 burns, subdivided into five groups. (Table 1.) Exposed parts of the body are involved first or exclusively. The modes of occurrence are listed in Table 1.

Gasoline burns came late to the hospital and presented a high incidence of complications, such as cellulitis and lymphangitis; scars and contractures made healing slow and painful and handicapped skin grafting.[2]

Kerosene burns are more prevalent in winter and among women, who are also the chief victims of cleaning fluid burns. Natural gas explosion burns rarely became infected in our series.

The "conflagration type" burns tend to be extensive and fatal. The most serious are the alcoholic "bed smokers." Seventeen died. One night we had nine fatal "conflagration" cases from four fires, some with laryngeal and pulmonary edema from inhalation of smoke and gases.

Ninety-nine patients were scorched by various hot objects. These burns were usually on the exposed parts of the body. They were usually deep but small in area. The often long delay in seeking medical aid was reflected in a high incidence of infection. Deaths were a rarity.

Of the 305 patients with burns due to hot liquids, many were infants and young children. Infection was frequent, 113 or 37 per cent, too often due to the common home practice of smearing grease over the raw area.

Friction burns, due to abrasion plus heat, are said to be slow to heal.[3] We had none.

Twenty-four cases of frostbite are included in the series. They are so classified in some texts, probably because the tissue reactions to the two noxae—heat and cold—are similar.[3,12] Six cases of deep frostbite went on to gangrene of the fingers and toes and amputation with an average

TABLE I

BURNS DUE TO TEMPERATURE CHANGES

Burn Agent	Sex	Age	Color	Location	How Occurred	Time for Treatment, Hr.	Days in Hospital	Time of Year	Infection	Death	Complication	Skin Graft	Remarks
Gasoline	82 M. 10 F. 92	34	83 wh. 8 col. 1 Mex.	77 exposed parts of body 15 scattered	Cleaning or working on car; lighting stove; using a blow torch	43	30	July Aug. Oct.	35 (38%)	12 (13%)	29 (31%)	13 (14%)	
Kerosene	25 M. 16 F. 41	35	25 wh. 16 col.	34 exposed parts of body	Starting fire; overturning lamp	27	34	Nov. Dec. Jan.	15 (36%)	8 (19%)	5 (12%)	5 (12%)	
Benzene Naphtha Turpentine Lacquer	21 M. 10 F. 31	32	82 wh. 2 Mex. 11 col.	22 exposed parts of body	Cleaning; starting a fire	29	22	July	11 (35%)	4 (13%)	4 (13%)	3 (9%)	
Gas explosions	24 M. 8 F. 32	27	25 wh. 7 col.	24 exposed parts of body	Stove explosion	20	17	All during year	4 (12%)	3 (9%)	5 (15%)	3 (9%)	
Fire; conflagration	113 M. 70 F. 183	27	131 w. 50 col. 2 Mex.	All over the body	Smoking in bed; conflagration; bonfire; too close to stove; clothes burned playing with matches	25	26	Spring Fall Winter	58 (44%)	47 (26%)	27 (14%)	30 (16%)	17 died in conflagration
Hot object	57 M. 42 F. 99	23	57 wh. 42 col.	Face, arms, legs, hands, feet, thighs	Stove, radiator, hot pipe	77	14	Spring Late fall	44 (44%)	2 (2%)	16 (16%)	6 (6%)	
Hot liquids	180 M. 125 F. 305	22	193 w. 109 col. 3 Mex.	Face, arms, back, exposed portions of body	Scald, coffee overturned; spill; thrown while cooking; fell into	47	18	All during year	113 (37%)	22 (7%)	18 (6%)	17 (6%)	

TABLE I (*Continued*)

Burn Agent	Sex	Age	Color	Location	How Occurred	Time for Treatment, Hr.	Days in Hospital	Time of Year	Infection	Death	Complication	Skin Graft	Remarks
Frost bite	19 M. 5 F. 24	45	21 wh. 3 col.	Feet, hands	Exposure	48	27	Winter	9 (37%)	8 (33%)	2 (8%)	0 (0)	
Burns Due to Rays of Light													
Sunlight	9 M. 1 F. 10	20	10 wh.	Back, legs, arms, shoulders	Sunbathing	75	3	July	2 (20%)	0 (0)	2 (20%)	0 (0)	
Burns Due to Electricity													
Electric current	3 M. 1 F. 4	25	3 wh. 1 col.	All over	Touched live wire	40	13	Nov.	2 (50%)	0 (0)	2 (50%)	0 (0)	
Burns Due to Chemicals													
Chemical	35 M. 18 F.	27	36 wh. 26 col.	Face, eyes, mouth, hands, lips	Thrown on, ate, splashed on	36	8	All during year	5 (9%)	3 (5%)	22 (42%)	2 (4%)	
Burns Due to Miscellaneous Causes													
?	126	24	?	All over body	Not stated	Many old cases	38	.....	35 (28%)	9 (7%)	8 (7%)	45 (36%)	45 old cases returned for skin grafts
Totals and Averages													
	1000	28	.....	.....	.....	45	25	.....	333 (33%)	110 (11%)	140 (14%)	124 (12.4)%	

three months hospitalization. There were two very chronic cases of frostbite ulcers of several years' duration.

Burns Due to Light Rays. In the ten sunburn cases, delay in entering the hospital was the rule. The stay was short. The only complications were nausea, vomiting and dizzy spells. We had no burns from ultra-violet light apparatus.

Electric Burns. The local effects of electric currents seem due mainly to the heat generated in the tissues, dessication and charring. Bone, tendons, ligaments and calloused skin offer the greatest electrical resistance to the passage of the current and, therefore, theirs was the greater damage.[6] The point-of-contact burn may appear slight and yet a deep slough occurs even weeks later.[6,7,10] We noted no ventricular fibrillation or respiratory failure,[10] nor any central nervous system effects simulating cerebral concussion or traumatic psychoses.[3] There were no cases of late optic atrophy, central retinal atrophy or lens cataract.[3,7]

Burns Due to Roentgen Rays and Radium. Roentgen ray and radium burns are most stubborn.[12] We were fortunate to have only one. It was cured by excision of the ulcer from the abdominal wall with subsequent skin grafting.

Burns Due to Chemicals. Fifty-three patients had chemical burns, many of them limited to the face and mouth. Although the hospital stay was usually short, complications were many and, as compared to thermal burns, occurred late.[11,15] There were ten cases of corneal ulcers, four cases of keratitis and seventeen cases of chronic conjunctivitis usually due to some lye. Two late strictures of the esophagus in children were due to lye. A rodent ulcer developed in a deep acid burn of the face.

Miscellaneous Series. The miscellaneous series of 126 cases, in which the cause of the burn was omitted from the history record, came in for a large share of skin grafting. Forty-five of these patients were readmitted to the hospital for this reason.

Delay in seeking medical aid promotes infection. The average delay in this series was forty-five hours. Three hundred and thirty-three, or 33.3 per cent, of the 1,000 burns became infected either before entrance or during their stay, but of the 295 patients who arrived within three hours, only forty-one, or 13 per cent, became infected.

Treatment. We are not concerned here with the effect of treatment on burns. We believe that our therapy in these cases was sufficiently uniform so that the interesting results obtained can be ascribed chiefly to three factors: the etiology, extent and the elapsed time before starting hospital treatment of the burn. As a rule, the burn was first washed with soap and water and débrided until reasonably clean, dried and sprayed first with fresh tannic acid solution and then with silver nitrate.

Prognosis. There were 136 cases, or 13.6 per cent, that presented some complication. "Shock" was usual with extensive burns. In forty-four cases shock was stated as the cause of death which commonly ensued within forty-eight hours. In feeble patients, a minor burn sometimes precipitated profound and fatal shock. Convulsive seizures preceded a fatal outcome in five cases.

In fifty of the series, toxemia and sepsis from infected burns were considered responsible for death, usually during the second week. Vomiting was an ominous sign. Of forty-eight patients who vomited, forty-one died, and all of the twenty-seven patients with "brownish" or "rusty" emesis died.

There were nine cases of bronchopneumonia, three of uremia, one osteomyelitis of the wrist, one pulmonary embolus and two cases of bulbar palsy.

There were two cases each of erysipelas of the face, of pertussis and chicken pox, and one case each of measles, scarlet fever and impetigo. A fatal case of tetanus developed on the thirteenth day of a burn.

The death rate due to burns at this hospital has not changed appreciably in

the last five years, although plasma and blood transfusions have been freely used since 1937. The death rate averaged 11 per cent for the three years 1935, 1936 and 1937; 11.8 per cent for 1938, and 12.9 per cent for 1939. Table 1 tabulates deaths according to their causative agents. Graph 1 tabulates ages at death.

CONCLUSION

The prognosis of burns on a standard form of therapy depends partly on the etiologic factors involved. This is a prognostic factor which hitherto has been comparatively neglected in the literature of burns.

The author wishes to acknowledge his indebtedness to Dr. Roger T. Vaughan for his revision of the article.

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SULFALLANTOIN IN THE TREATMENT OF WOUNDS

ALLISON E. IMLER, M.D.
PHILADELPHIA, PA.

SULFALLANTOIN (p-amino benzene sulfonamide glyoxyldiureide) has been termed a loose addition product of sulfanilamide and allantoin, combining the bacteriostatic properties of the former substance with the cell-proliferating action of the latter. This new compound* has been used locally in the form of a 2 per cent ointment in the treatment of twenty-five cases, including operative defects, decubitus ulcers and donor sites of skin grafts (Davis or pinch grafts).

Clinical observation indicates that the ointment has a soothing action and in most cases effects rapid improvement in the appearance of the wound. Two cases of irradiation necrosis involving the skin and subcutaneous tissues failed to show the usual rapid improvement, but the foul odor typical of such lesions soon disappeared and both patients stated that they were more comfortable. Neither local nor systemic reactions have been observed following the use of this ointment.

If necrotic or devitalized tissue is present, surgical débridement is essential. It is frequently desirable to irrigate the wound daily with ½ per cent chlorazene solution, normal saline or some other suitable agent.

Two particularly interesting cases treated with sulfallantoin are described below:

CASE 1. W. H., a white male, aged sixty-six, was admitted to Jeanes Hospital March 31, 1941. At the age of four years, the patient fell into a bonfire and suffered severe burns of the buttocks and thighs. The burned areas healed slowly, with formation of a thick layer of scar tissue. At intervals of one and one-half to two years the scars on the buttocks became painful and ulcerated for a period of several months, usually healing imperfectly with formation of fissures. An ulcerative lesion which had persisted in the scar of the left

FIG. 1. Squamous carcinoma arising in old burn scar of buttocks.

buttock for almost three years was excised in 1927 and the operative defect skin grafted successfully. In 1933, an ulcerative lesion in the scar of the right buttock was excised and the defect grafted. In October, 1939, the center of the scar became sensitive and extensive ulceration rapidly developed.

Multiple biopsy specimens contained squamous cell carcinoma. On April 11, 1941, the involved area was widely excised with the electric cutting current. Figure 1 shows the wound prior to operation. On the sixth postoperative day (Fig. 2) sulfallantoin therapy was instituted. The ointment was applied each morning following irrigation of the wound with ½ per cent chlorazene solution. There was rapid improvement in the wound, and a healthy base of granulation tissue soon developed. Figure 3 shows the clean, granulating wound on the fourteenth postoperative day. On April 29, 1941, a Davis skin graft was carried out, using skin from the interscapular area. Sulfallantoin ointment was applied daily to the doner sites, and all were completely healed within ten days. All of the skin grafts were successful and the operative area is in excellent

*The Research Department of the Schuylkill Chemical Company, of Philadelphia, supplied the material necessary for carrying out this study.

condition. In view of the location of the wound, the result in this case was remarkably good.

Case II. G. H., a white male, aged sixty-four, was admitted to Jeanes Hospital on December 27, 1941, with a history of bloody stools for a period of one year. Examination revealed an adenocarcinoma of the rectum. On January 21, 1941, a one-stage abdominoperineal resection of the rectum was carried out. Questionable invasion of the prostate necessitated wide excision anteriorly, and on February 8, 1941, a vesicoperineal fistula developed. The postoperative period was further complicated by a cellulitis of the lower abdomen and scrotum which necessitated incision and drainage of these areas. The patient's condition remained critical, and a large decubitus ulcer appeared in the sacral region. On March 29, 1941, sulfallantoin ointment was prescribed and applied twice daily. Although urinary drainage through the perineal wound persisted, the ulceration was almost completely healed after two weeks of sulfallantoin therapy.

Fig. 2. Appearance of wound on sixth postoperative day.

Fig. 3. Clean, granulating wound on the fourteenth postoperative day.

SUMMARY

1. Encouraging results have been obtained in the treatment of twenty-five wound cases with sulfallantoin ointment.

2. No local or systemic reactions to the drug have been observed.

3. Ulcerations resulting from intensive irradiation are apparently not influenced by the drug.

RETROPERITONEAL HEMORRHAGE*

WITH SPECIAL REFERENCE TO THE ACCOMPANYING PARALYTIC ILEUS

JOHN E. KARABIN, M.D.
Assistant in Surgery, University of Illinois College of Medicine†
EVANSTON, ILLINOIS

RETROPERITONEAL hemorrhage may be of several varieties; it may be secondary to various etiological factors and is often difficult to recognize. It is invariably associated with a paralytic ileus. Any accumulation of blood found abnormally in the retroperitoneal tissues is considered a retroperitoneal hemorrhage. The condition may be trivial with such a small amount of hemorrhage that recovery occurs quickly and without serious complications. On the other hand, it may be quite serious and death may result within a few hours. The outcome usually depends upon the underlying etiological condition. (Fig. 1.)

The following classification, which was compiled from case reports in the literature, is presented and includes the various etiological conditions which predispose to retroperitoneal hemorrhage. (Table I and II.)

TRAUMATIC

a. Nonoperative:
1. Direct injury to muscle, kidney, blood vessel or other tissue situated retroperitoneally.
2. Fractures of the ribs, vertebrae or pelvis.

b. Operative:
1. Secondary to any operative procedure related to the retroperitoneal tissues.

NONTRAUMATIC

a. Diseases of the blood vessels which are anatomically retroperitoneal: aneurysm, spontaneous rupture of blood vessels associated with arteriosclerosis or hypertension.
b. Diseases of the blood: leukemia and hemophilia most common.
c. Diseases of the kidney: nephritis, hydronephrosis, calculi, cysts and neoplasms.
d. Diseases of the retroperitoneal tissues: infections, neoplasms, embolic or thrombotic phenomena.
e. No demonstrable cause: spontaneous hematoma unassociated with any demonstrable pathological condition.

Several unusual cases of retroperitoneal hemorrhage were observed at the Evanston Hospital and are presented in this report. In addition, seven cases of abdominal aortic aneurysm, which ruptured into the retroperitoneal space are submitted because of the interesting diagnostic problems present.

CASE I. RETROPERITONEAL HEMORRHAGE OCCURRING AFTER APPENDECTOMY

Reference to retroperitoneal hemorrhage as a complication of an appendectomy could not be found in the literature. Because of the rarity of the condition and the surgical importance associated with the condition, the following case is presented:

Mr. E. H., aged thirty-nine, entered the Evanston Hospital on the service of Dr. F. Christopher for an interval appendectomy. A retrocecal appendix was removed through a McBurney incision which had to be enlarged slightly by cutting the upper transverse fibers of the internal oblique muscle. Otherwise the operation was uneventful. The immediate post-

* From the Evanston Hospital, Evanston, Illinois, and the Department of Surgery, University of Illinois College of Medicine.
† Formerly Assistant in Surgery, University of Illinois College. At present Instructor in Surgery, Northwestern University Medical School.

operative recovery was good. The pulse rate varied between 60 and 80. Six hours after operation the patient suddenly experienced a pain in his incision associated with nausea. The pulse rate ranged between 100 and 120. Blood pressure was 80 mm. of mercury systolic and 40 mm. of mercury diastolic. The skin was pale, cold and clammy. A diagnosis of postoperative hemorrhage was made and he was returned to the operating room. The incision was explored and a large retroperitoneal hematoma was evacuated. There was an estimated 500 to 600 cc. of blood in the retroperitoneal space. The bleeding point in the internal oblique muscle was ligated. No hemorrhage was found in the peritoneal cavity. The wound was closed with drainage down to the peritoneum and a transfusion was given. The postoperative course was stormy due to an intractable paralytic ileus secondary to the retroperitoneal hemorrhage. Gradually the ileus was overcome and the patient was discharged on the twelfth postoperative day.

The source of the retroperitoneal hemorrhage occurring in the above case was the lateral ascending branch of the deep circumflex artery. (Fig. 2.) This vessel is regarded as the larger and terminal branch of the deep circumflex iliac artery and is situated about one inch from the anterior superior spine of the ilium. It ascends between the transverse and internal oblique muscles to about the level with the umbilicus. Two veins accompany this artery.

Undoubtedly this vessel has been encountered frequently during the course of an appendectomy through a McBurney's incision. However, its surgical importance has been limited to indicate the point of the intermuscular plane between the transverse and internal oblique muscles. Because of its position it is subject to trauma, thus ligation of this vessel when encountered is advisable.

CASE II. RETROPERITONEAL HEMORRHAGE OCCURRING AFTER A VAGINAL HYSTERECTOMY

Retroperitoneal hemorrhage developing by way of the broad ligament was observed in a patient who had undergone a vaginal hysterectomy.

TABLE I

NONTRAUMATIC GROUP (NO HISTORY OF TRAUMA AS A CAUSE OF RETROPERITONEAL HEMORRHAGE)

Author	No. of Cases	Diagnosis	Treatment	Result
Eiss[3]	1	Spontaneous perirenal hematoma	Operation	Recovery
Matheson[5]	1	Spontaneous retrocecal hematoma	Operation	Died
Marlow[4]	1	Spontaneous perirenal hematoma	No operation	Recovery
Bruce[7]	1	Spontaneous hematoma in hemophiliac	Operation	Died
Manizade[8]	1	Spontaneous hematoma in leukemia	Operation	Died
Cole[6]	1	Spontaneous retrocecal hematoma	Operation	Recovery
Bonar[10]	1	Ruptured abdominal aortic aneurysm	Operation	Died
Crile, Jr.[9]	1	Spontaneous rupture mesenteric vessel	Operation	Recovery
Polkey and Vynalek[1]	178*	Perirenal nontraumatic hematomas	47 no operation 62 nephrectomy 43 drainage	47 died 15 died 17 died
Karabin	7	Ruptured abdominal aortic aneurysm	3 operation	7 died

*Collected cases.

Mrs. M. J., aged thirty-seven, entered the Evanston Hospital on the service of Dr. P. Schneider because of an early toxemia of pregnancy. The condition threatened her life, thus a therapeutic evacuation of the uterus was done. An attempt was made to sterilize the patient through a posterior colpotomy. During this procedure a vessel was accidentally torn and because of the persistent bleeding a vaginal hysterectomy was done. The patient went into shock but improved after several transfusions. The postoperative course was stormy. On the first day after operation the temperature was 104.6°F. The pulse rate was 130; the quality was poor. There was a marked pallor. A mass was found in the right lower quadrant of the abdomen which was thought to be a hematoma about the size of a grapefruit. On the second postoperative day the abdomen was distended and Wangensteen suction was instituted. The patient was very toxic due to the intractable paralytic ileus. On the fifth postoperative day there was a profuse vaginal discharge of old blood and a decrease in the size of the hematoma. The distention of the abdomen gradually diminished with the evacuation of the hematoma. The patient made a gradual recovery and was discharged thirty-eight days after operation.

The underlying causes of her stormy postoperative course were no doubt the retroperitoneal hemorrhage and operative shock. Improvement occurred concurrently with the spontaneous evacuation of the hematoma. Fortunately, it was not necessary to drain the hematoma surgically for any additional injury might have been fatal.

The following seven patients died of an aortic abdominal aneurysm which had ruptured retroperitoneally:

CASE III. J. R. C., aged fifty-four, a white male, presented a history of severe backache and generalized abdominal pain which occurred while working. He had vomited once. He collapsed and was seen by a physician who found a blood pressure of 160 mm. of mercury systolic and 110 mm. of mercury diastolic. Further findings at this time were essentially normal. He was then removed to the Evanston Hospital whereupon entrance, three hours after the onset, a blood pressure of 230 mm. of mercury systolic and 140 mm. diastolic was recorded. One-half hour after entrance to the hospital he again collapsed and a blood pressure of 80 mm. systolic and 60 mm. diastolic was found. The pulse rate varied from 86 to 100. At this time there was marked pallor. His pain was now referred into the suprapubic region and the abdomen was found to be tender over a mass situated between the iliac crest and the

TABLE II

TRAUMATIC GROUP (TRAUMA AS A CAUSE OF RETROPERITONEAL HEMORRHAGE)

Author	No. of Cases	Diagnosis	Treatment	Result
Bonar[10]	1	Traumatic hematoma; melanosarcoma of kidney found one year later	Operation	Died
Cole[6]	3	1. Fractured ribs and kidney trauma	Operation	Recovery
		2. Bullet wound of kidney	Operation	Died
		3. Fracture 4th L. Vert.	Operation	Recovery
Christopher[12]	1	Fractured ribs	Operation	Recovery
Eiss[3]	1	Traumatic hematoma	Operation	Recovery
Hinton[11]	19	17 traumatic rup. kidney	17 no operation	16 recovered
		2 traumatic hematoma without kidney injury	2 operations	1 died
				1 died
				1 recovered
James[20]	1	Traumatic hematoma	Operation	Recovery
Neller[21]	2	Fractured pelvis	Operation	Died
Susman[22]	1	Traumatic hematoma	Operation	Died
Karabin	2	1. Postappend.	Operation	Recovery
		2. Postvag. hysterectomy	No operation	Recovery

costal margin. He continued to vomit through the night but on the next day he seemed to be improved except for persistent hiccoughing. tests were negative. Upon examination the temperature was 98.6°F.; the pulse rate was 80 and of good quality. The blood pressure was

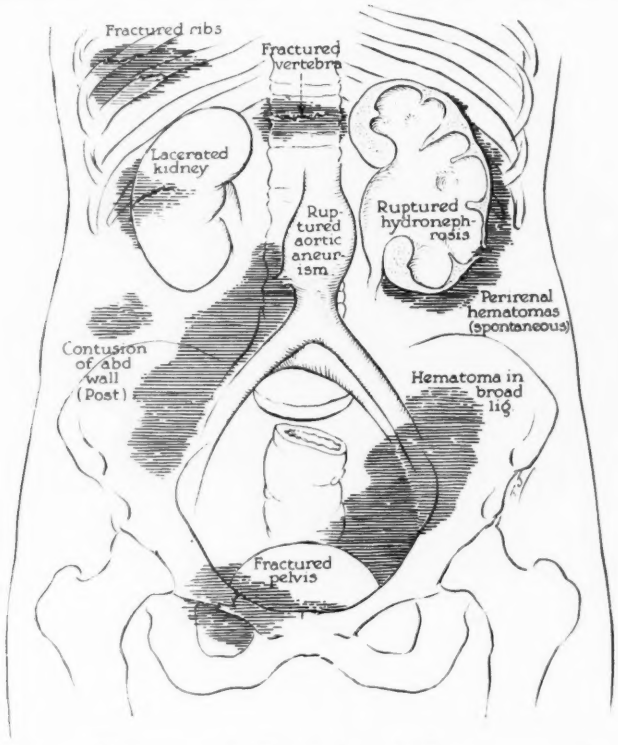

FIG. 1. Diagrammatic illustration of the common etiological factors in retroperitoneal hemorrhage.

The abdomen was distended. On the second day he suffered another attack of colicky pain in the left side of the abdomen and again suddenly collapsed. The patient was in severe shock and did not respond to the usual methods and died. A diagnosis of an intra-abdominal hemorrhage was made but no cause was known. The Kahn test was negative. Postmortem examination revealed an abdominal aneurysm which had ruptured into the retroperitoneal space. There was a marked generalized arteriosclerosis which was probably the basis for the formation of the aneurysm.

CASE IV. W. A. P., aged eighty-two, a white male, presented a history of abdominal pain for forty-eight hours which was referred to the right leg. Twenty-four hours after the onset of the disease he was nauseated and had vomited many times. The vomitus was of a bilious character. There was no past history of similar attacks although he had complained of some pains in his legs for ten days prior to his admission. He stated that he had had an abdominal aortic aneurysm for about four years but was never troubled by it. Serological

142 mm. of mercury systolic and 92 mm. of mercury diastolic. A pulsating tender mass situated in the midline between the umbilicus and pubis was about the size of an orange. A bruit was heard over the mass. There was rigidity and tenderness in the right lower quadrant and rebound tenderness was elicited. A diagnosis of appendicitis was made and under local anesthesia a normal appendix was removed. No definite cause for the patient's distress could be found but a retroperitoneal hemorrhage was suspected. The postoperative course was stormy primarily because of a severe paralytic ileus. The patient continued to get weaker. The pulse rate increased to 110 and became weak and irregular. He died on the third day postoperatively, six days after the onset of the disease. Postmortem examination revealed an abdominal aortic aneurysm which had ruptured into the retroperitoneal space. There was an associated generalized arteriosclerosis.

CASE V. P. L., a seventy-three year old white male, entered Evanston Hospital with a history of a generalized lower abdominal pain

for four days. The pain was not localized or referred and was a severe, constant aching pain. He had vomited several times. There was no

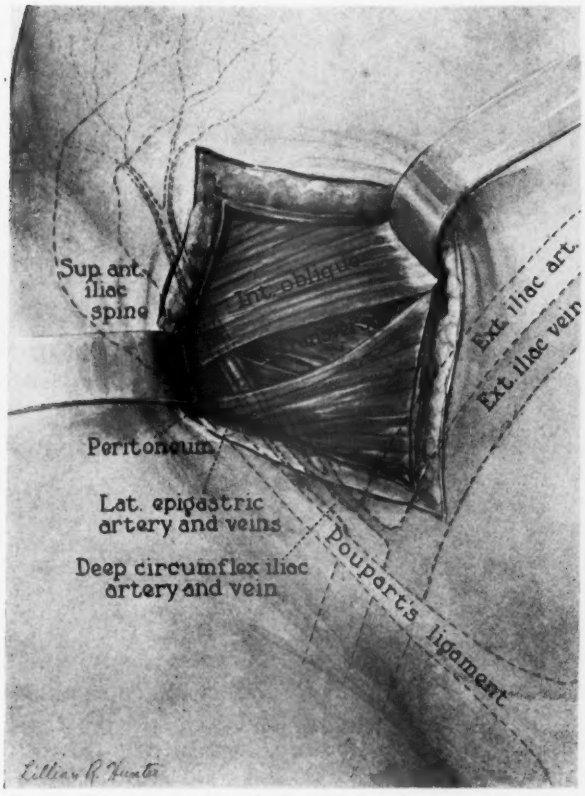

Fig. 2. Illustrates the relationship of the lateral ascending branch of the deep circumflex iliac artery which may be encountered in a McBurney incision. This vessel was the source of serious retroperitoneal hemorrhage following an appendectomy in Case I.

past history of any similar attacks of pain. Upon examination the blood pressure was 120 mm. of mercury systolic and 85 mm. of mercury diastolic. The pulse rate was 60 with regular rhythm and of good quality. The entire abdomen was rigid. Just below and to the right of the umbilicus was a tender, pulsating mass. A bruit was heard over the mass. A diagnosis of aortic aneurysm was made and confirmed by *x*-ray of the abdomen. (Fig. 3.) The plate showed an ovoid mass in the midline with calcified walls. There was no erosion of the lumbar vertebrae in the lateral view of the spine. The urine showed gross blood. He was treated conservatively and on the third day after admission and seven days after the onset of the disease he suddenly collapsed and died. No postmortem examination was done. The clinical diagnosis was a ruptured aortic aneurysm into the retroperitoneal space.

Case VI. F. W., a sixty-four-year old white male, entered the Evanston Hospital with a history of sudden, severe, abdominal pain occurring at 2 A.M. He collapsed and following

Fig. 3. *X*-ray plate of the abdomen illustrating an abdominal aortic aneurysm. Arrows point to the wall of the aneurysm which shows up largely because of the calcification (Case V).

this developed a marked pallor. There was no vomiting. The past history was negative. He had a known hypertension for several years. The Kahn test was negative. Physical examination revealed a somewhat stuporous, markedly pale patient with a pulse rate of 90 of fair quality. The blood pressure was 60 mm. of mercury systolic and 40 mm. of mercury diastolic. The abdomen was moderately tender and rigid in the right lower quadrant. There were no palpable masses. No definite diagnosis could be made; thus, an exploratory laparotomy was done. Exploration revealed an abdominal aortic aneurysm which had ruptured retroperitoneally. The aneurysm was not disturbed and the abdomen closed. The immediate postoperative condition was good except for a moderate abdominal distention. On the first postoperative day he complained of severe backache. The pulse rate was 118 and of fair quality. On the second day and three days after the onset of the disease he developed a sudden severe pain in the back referred to the

right lower quadrant and then collapsed and died. Postmortem examination confirmed the operative findings of an abdominal aneurysm which had ruptured retroperitoneally. There was a marked generalized arteriosclerosis.

Case vii. W. J., aged seventy, had suffered a sudden severe knife-like pain in the right lower quadrant of the abdomen while lifting a heavy object. He became weak and pale. The pain was referred to his right leg. There was no nausea or vomiting. The past history was essentially negative. He entered the Evanston Hospital twenty-four hours after onset in profound shock. The pulse rate was 92 and weak in quality. The abdomen was distended and tender in the right lower quadrant. A soft, pulsating mass about the size of an egg was found just to the right of the umbilicus. A diagnosis of aortic aneurysm and a possible appendicitis was made. An exploratory laparotomy was done which revealed a retroperitoneal hematoma from a ruptured abdominal aneurysm. The pain persisted postoperatively and the pulse became weaker. He died suddenly on the first postoperative day, three days after the onset of the disease. Postmortem examination confirmed the operative findings.

Case viii. J. W. B., aged sixty-nine, gave a history of pain in the lower abdomen, cramplike and not referred. He had been well until twelve hours before entrance to the Evanston Hospital. Soon after the pain developed he collapsed and developed a marked pallor. Physical examination revealed a blood pressure of 122 mm. of mercury systolic and 82 mm. of mercury diastolic. The pulse rate was 80 and of poor quality. The patient was stuporous. The abdomen was rigid and tender in the lower half. There were no palpable masses. The pain became worse and was referred into the left leg. Singultus was marked. The abdomen became distended and he collapsed and died forty-eight hours after the onset of the disease. Postmortem examination revealed an abdominal aortic aneurysm which had ruptured into the retroperitoneal space. There was a marked generalized arteriosclerosis.

Case ix. L. E. B., eighty years of age, entered the Evanston Hospital with a history of severe epigastric pain of twenty-four hours' duration which was referred to the back. There was considerable vomiting and hiccoughing. There was no history of previous attacks. Examination revealed a pulse rate of 80 of fair quality. The blood pressure was 140 mm. of mercury systolic and 90 mm. of mercury diastolic. The abdomen was distended. Tenderness was present in the epigastrium. In the left upper quadrant there was a pulsating mass which was thought to be an aortic aneurysm. However, because of the persistent pain and tenderness an exploratory laparotomy was done. At operation an abdominal aortic aneurysm which had ruptured into the retroperitoneal space was found. The abdomen was closed without disturbing the hematoma. The patient died suddenly twenty-four hours after operation and three days after the onset of the disease. A postmortem examination confirmed the operative findings. There was a generalized arteriosclerosis.

The clinical findings in patients with an abdominal aneurysm ruptured retroperitoneally are quite similar to the signs and symptoms of retroperitoneal hemorrhage from other causes. The onset of the attack occurs with a sudden pain without any history of previous similar attacks. The abdominal pain may be generalized or localized to either side in the lower abdomen or referred into the legs. Back pain is a frequent complaint. At varying intervals (few minutes to several hours) after the onset of pain the patient feels faint and collapses. Following the collapse there is usually a marked pallor. The blood pressure is low and the pulse rate rapid. A mass may be palpable. The abdomen is rigid and tender at the onset, but as the disease progresses the rigidity usually diminishes and an ileus develops. The ileus may appear from twenty-four hours to five days after the onset of the hemorrhage. This distention is frequently marked and does not respond to usual methods of treatment. A bruit is often heard over the aneurysm but not always heard over a hematoma resulting from a rupture of an aneurysm. Severe vomiting and hiccoughing are often present. The laboratory findings are of no diagnostic value early in the disease but later an anemia may develop. Serological tests are usually negative.

The most valuable procedure in the diagnosis of an abdominal aneurysm is an *x*-ray examination of the abdomen. As in patient P. L. (Fig. 3) an *x*-ray plate of the abdomen revealed an aneurysm which at the onset of the disease was not palpable because of the abdominal rigidity. Kampmeir[2] found that the *x*-ray examination was positive in 75 per cent of the cases and that 50 per cent of the cases showed a pressure erosion of the bodies of the vertebrae without destruction of the intervertebral discs which is pathognomonic of abdominal aneurysm. Farmer[23] suggested a pneumoperitoneum be produced in order to outline the aneurysm as an aid in its diagnosis, however, this procedure does not seem necessary, for ordinarily a lateral and anteroposterior view will suffice. (Fig. 3.)

The prognosis in ruptured abdominal aortic aneurysm is poor. Death usually occurs within six months after the discovery of the condition. Death occurs from hemorrhage as a result of a rupture of the aneurysm, usually retroperitoneally. Surgical intervention such as wiring has been tried with little success for complete cure. Recently Bigger,[24] Elkin[25] and Matas[26] have presented encouraging results in the treatment of aneurysm of the abdominal aorta by ligation.

The findings presented by patients with a perirenal nontraumatic hematoma are quite similar to those in ruptured abdominal aortic aneurysm. Polkey and Vynalek[7] found that the most common signs and symptoms found in these patients were pain in the region of the kidney, palpable tumors and signs of hemorrhage. With a palpable tumor or dullness in the flank which progressively increased in size and was associated with signs of hemorrhage, one could almost be sure of a diagnosis of of retroperitoneal hemorrhage. Nausea, vomiting, meteorism and ileus were not uncommon. Death usually occurred from secondary anemia, ileus, pneumonia, sepsis, uremia or operative shock. In the treatment of the condition they found that of the forty-seven patients treated conservatively, there was a 100 per cent mortality. When nephrectomy was done the mortality was 24 per cent and when drainage alone was instituted the mortality was 40 per cent. Such findings would indicate that the method of choice was a nephrectomy.

The signs and symptoms of patients in traumatic retroperitoneal hemorrhage are not unlike those presented in the nontraumatic group. Exploratory laparotomy may often be necessary because of the inability to differentiate the condition from perforation of a viscus. The treatment of patients in this group varies considerably. Hinton[11] advocates conservative treatment in traumatic rupture of the kidney with retroperitoneal hemorrhage. He treated seventeen such patients conservatively with sixteen recoveries. Cole[6] explored three patients with traumatic retroperitoneal hemorrhage which simulated a generalized peritonitis. Two of these patients recovered.

The prognosis in any patient with retroperitoneal hemorrhage must be guarded. The underlying cause of the hemorrhage will determine in most cases the outcome of the disease. In any case, the presence of blood in the retroperitoneal tissues must be considered as a serious problem.

Paralytic ileus as a complication of retroperitoneal hemorrhage is not uncommon. Lenormant and Cordier[13] emphasized the importance of ileus as a complication in such patients and presented various etiological factors. Eight of the nine patients presented in this report developed an ileus. When an intractable ileus develops following traumatic retroperitoneal hemorrhage, it is often necessary to do an enterostomy. No doubt the procedure to be followed will depend primarily upon the etiological factor and the judgment of the attending physician.

The fact that blood in the retroperitoneal space was an irritant was proved experimentally by Guibal and Cuenot.[14] Tixier and Clavel[15] studied the relationship of the retroperitoneal syndrome to the gastrointestinal reflex from the kidney. A reflex,

the renodigestive, was demonstrated, and a syndrome simulating a peritonitis was developed experimentally by stimulation of the kidney and retroperitoneal tissues. They could not conclusively explain the mechanism of the reflex but suggested that it involved several factors. It was either a summation of the irritating impulses, an individual predisposition or a sensitization of nerve centers through an infection or intoxication. This syndrome was observed in the above patients during the acute stage of the retroperitoneal hemorrhage and was no doubt due to a reflex as suggested. Cole[6] also observed such patients with a so-called retroperitoneal syndrome simulating a peritonitis and thought it was a reflex through irritation of the sympathetic nervous system.

Considerable controversy as to the mechanism of this reflex has been found in the literature. The majority believe that the reflex occurs through the irritation of the splanchnic nervous system, as first advocated by Starling.[16] However, further evidence suggests that the mechanism involves the parasympathetic system as well as the splanchnic system. Kuntz[17] presented the following facts concerning the gastrointestinal physiology: Bilateral section of the vagi above the diaphragm resulted in a diminution in the tonus of the gastrointestinal musculature and retardation of peristalsis. However, both tonus and peristaltic activity were soon restored to the condition which existed before vagotomy. Bilateral section of the splanchnic nerves increased the tonus and augmented peristaltic activity. This also subsided in a relatively short time and was often followed by a hypotonic condition. However, section of both the vagus and the splanchnic nerves resulted in a marked hypotonicity of peristalsis. Apparently the splanchnic system exerted an inhibiting action which overcame the stimulating action of the parasympathetic system. This condition was of longer duration. Such evidence indicated that the motor and inhibitory impulses to the gastrointestinal tract were conducted through the sympathetic and parasympathetic systems with equal facility. To support this contention, Graham and his associates[18] studied the reflex of vomiting in peritonitis and found that the reflex impulses traveled through either system and that only through section of both systems could the reflex be abolished. Thus, one may surmise that the mechanism of the reflex from the retroperitoneal hemorrhage developing at the onset of the disease occurs through irritation of both systems and not the sympathetic system alone. After a retroperitoneal hemorrhage, a paralytic ileus develops as a late sign of the irritation of the retroperitoneal tissues. The ileus occurs from twenty-four hours to five days after the onset of the disease.

That the ileus is due to paralysis of the sympathetic and parasympathetic nervous systems was suggested by Walton[19] and is supported by the clinical evidence in the patients presented in this report. The ileus is severe and does not respond to ordinary measures until the paralyzing effect of the retroperitoneal hemorrhage is removed. The paralysis is temporary and not unlike the transient paralysis of nerves due to hematomas which occur in other parts of the body. Although no positive proof can be given to the above mechanism of the ileus, it seems that the clinical picture presented by patients with an ileus associated with retroperitoneal hemorrhage can be better explained upon the basis of a temporary paralysis of the sympathetic and parasympathetic systems, rather than a reflex through the splanchnic system alone.

The treatment of such an ileus is directed at the cause. Removal of the irritating hematoma is desirable but often difficult. When this is impossible it may be necessary to relieve the ileus by an enterostomy. If the patients can be treated conservatively without endangering their life because of toxicity or starvation, such a procedure should be followed. The prognosis varies and depends upon the underlying cause.

SUMMARY

Nine patients with retroperitoneal hemorrhage are reported. One hemorrhage occurred after an appendectomy, another after a vaginal hysterectomy, and seven as a result of a ruptured abdominal aortic aneurysm.

Retroperitoneal hemorrhage may be classified into hemorrhage due to nontraumatic and traumatic causes. The signs and symptoms are quite similar in both groups but may vary with the underlying cause of the hemorrhage.

The treatment of the retroperitoneal hemorrhage will depend upon the etiology of the condition.

At the onset of the hemorrhage there is an abdominal syndrome simulating a generalized peritonitis and is due to a reflex, most likely from an irritation of the sympathetic and parasympathetic nervous systems.

After this acute stage, a paralytic ileus usually develops. The ileus may occur from twenty-four hours to five days after the onset of the hemorrhage. It is probably due to a paralysis of the sympathetic and parasympathetic systems, rather than a reflex irritation of the splanchnic system.

The prognosis in patients with retroperitoneal hemorrhage will vary and depend entirely upon the etiology of the condition.

I am grateful to Doctors R. Blessing, F. Christopher, J. P. Grier, W. R. Parkes, P. Schneider and H. O. Weishaar who have kindly allowed me to use the above case reports.

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INGUINAL HERNIA

A NEW CONCEPT AND OPERATION

HERBERT E. STEIN, M.D.
NEW YORK, NEW YORK

THE Ancient Egyptians knew of the existence of hernia; the Greeks had a significant word for it based on the word *Ερνος*, a branch or outgrowth; the modern Anglo-Saxons gave hernia a different implication and considered it a rupture; the Teutons called it a break (Bruch). Contemporaneously this conception of tear or break is no longer tenable, it being generally agreed that the condition is indeed an outgrowth of peritoneum, which outgrowth, however, is always congenital. This applies only to an indirect hernia.

To clarify the nomenclature, it might here be interpolated that a differentiation must be made from the conception of the congenital nature of inguinal hernia as entertained about twenty-five years ago when only such hernias were considered congenital in which the testicle was contained within the hernial sac, i.e., the hernial sac and the tunical vaginalis being one and continuous.

If, however, the present day belief is correct that all indirect inguinal hernias are congenital, how can we explain the fact that the clinical manifestations of hernia, that is, the descent of abdominal viscera into the sac usually occurs for the first time only in adult life? There are only two deductions: (1) that the congenital theory is incorrect, or, (2) that the mechanism has broken down by which the abdominal contents had been prevented from entering the sac. I am definitely inclined toward this latter hypothesis. This mechanism, the inguinal valve, if I may coin the term, is dependent upon three factors: (1) a small internal ring; (2) an obliquity of the inguinal canal passing at different levels through the abdominal wall; (3) a proper functioning, sliding door closure of the internal oblique muscle. This is accomplished when its contraction straightens and shortens its own arched line, thus tending to cover over and protect the internal ring.

The inadequacy of this inguinal valve may be due to three causes: (1) an enlargement of the internal ring, which thereby approximates the external ring and thus, (2) converts an oblique canal into an almost vertical one; (3) anatomical muscular deviations: (a) congenital, the further away from the anterior superior spine of the ilium the muscle takes its origin the less protection it can afford the internal ring, (b) acquired, general debility with weak muscular contraction; (4) increased intra-abdominal pressure from tumor, fluid, etc. Whether intra-abdominal pressure can be sufficiently increased by external violence to break down the inguinal valve, is very doubtful.

Fallacy of Most Operative Repairs. Suture of the muscle to Poupart's ligament, the *sine qua non* of the Bassini operation with the idea of building up the floor of the hernial canal is illogical. First, there is no weakness of the floor; second, nowhere in the human economy is muscle structure used as a fixed buffer state, it having only four functions, motion, locomotion, sphincteric control and stabilization; third, muscular fixation is bound to result in atrophy of disuse and thus, when and if the suture gives way, the muscle is weaker than before operation, with the recurrence often larger than the primary hernia.

In an attempt to re-establish physiological normalcy and to overcome some of the operative fallacies, I have been using the fol-

* From the Surgical Service of the Hospital for Joint Diseases, Dr. Bodenheimer and Dr. Beller.

lowing technic for the past five years, the detailed operation having been reported in a previous article:[1] (1) eradication of the sac; (2) narrowing of the internal ring with one to three mattress sutures taken at the cephalad rather than at the caudal quadrant of the ring, so as to avoid injury to the deep epigastric vessels; (3) placing the internal oblique muscle in better functioning position, never by passing sutures through the belly of the muscle but by incising the fascia of the internal oblique muscle, and suturing the ensuing lateral edge to Poupart's ligament with interrupted mattress sutures. Mattress sutures are used so as to give wider apposition. Transplantation of the cord seems of little moment.

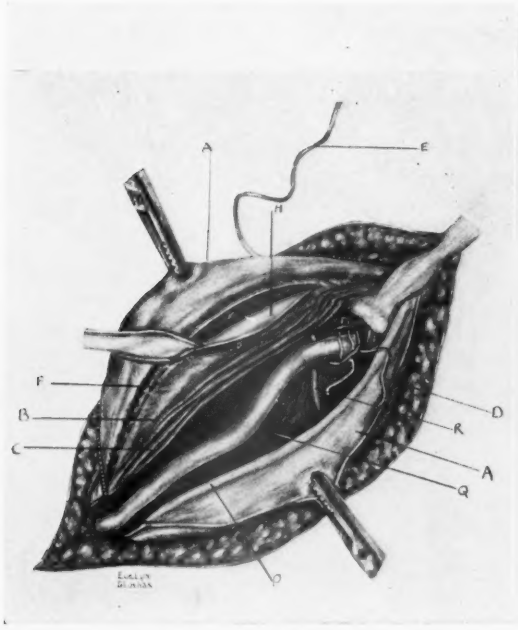

Fig. 1.

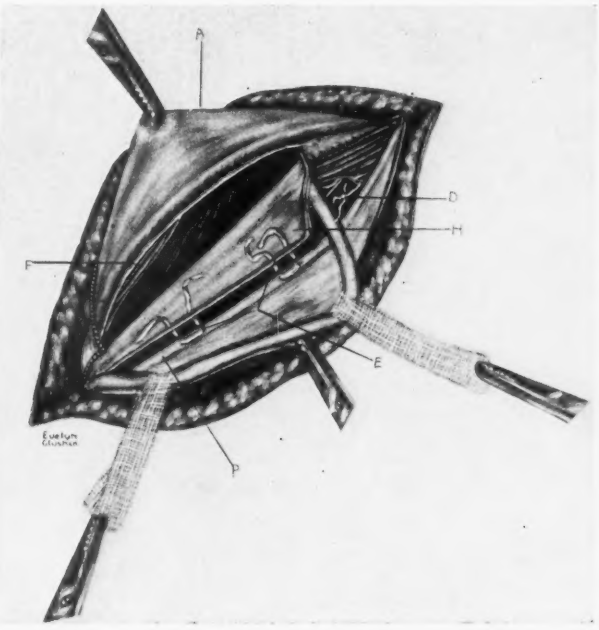

Fig. 2.

Figs. 1 and 2. A, aponeurosis external oblique muscle; B, aponeurosis internal oblique muscle; C, internal oblique muscle; D, suture through internal ring; E, fascial suture; F, incision of aponeurosis internal oblique muscle; H, flap of internal oblique aponeurosis; P, Poupart's ligament; Q, transversalis fascia; R, deep epigastric vessels.

Direct hernias have two clinical types: one in which there is an actual opening in the transversalis fascia through which a definite peritoneal pouch or sac protrudes, and a second type in which there is a relaxation of the transversalis fascia permitting a general bulge. Preoperatively they cannot be differentiated. Their relative importance lies in the fact that the first type may become incarcerated or strangulated, the latter never. I have seen two such cases. In the former, the sac must be eradicated, the neck transfixed and the opening in the transversalis fascia closed; in the second type the transversalis fascia is exposed well posteromedially to the internal oblique muscle, incised without opening the peritoneum and its cut edge together with the cut edge of the fascia of the internal oblique, sutured to Poupart's ligament.

It is my impression that in the direct hernias, better contact is obtained and less tension occurs at Hasselbach's triangle by transplanting the cord subcutaneously or subaponeurotically. Good exposure, especially, at the pubic spine, is essential.

In the first series of cases, fascial strips were taken from the external oblique aponeuroses and reinforced by catgut. Fascia lata was utilized only in the recurrent cases in which previous infection had destroyed the external aponeurosis.

A second series of cases has been started in which fine silk is being used throughout, but sufficient time has not yet elapsed to warrant a report.

STATISTICS

	10–20	21–30	31–40	41–50	51–60	61–70	Operations
Indirect	8	19	16	19	15	15	82
Direct	0	4	15	12	10	6	47
Indirect-direct	..	3	2	4	2	..	11
Recurrent, indirect	..	3	1	1	3	1	9
Recurrent, direct	..	1	3	2	..	..	6
Recurrent, indirect-direct	..	..	..	1	..	..	1
Recurrent, Spiegel	..	..	..	1	..	..	1
Total patients	8	30	37	40	30	12	157

TIME SINCE OPERATION, YEARS

	7	6	5	4	3	2	1	Patients
Indirect	2	7	8	22	11	19	10	79
Direct	2	1	3	7	7	5	12	37
Indirect-direct	..	..	1	2	1	1	1	6
Recurrent	..	..	2	2	7	3	2	16
Total	4	8	14	33	26	28	25	138

Types

	Number
Indirect	82
Direct	47
Indirect-direct	11
Recurrent, indirect	9
Recurrent, direct	6
Recurrent, indirect-direct	1
Recurrent, Spiegel	1
Total	157

Age

Second decade	8
Seventh decade	12
Fifth decade	40
Third, fourth, sixth, each about	32

Sex

Males	133
Females	4

Recurrences

Primary:

Indirect: 1.4 per cent
82 hernioplasties, 71 follow-up, 1 recurrence

Direct: 11.7 per cent
43 hernioplasties, 30 follow-up, 4 recurrences

Indirect-direct: 12.5 per cent
11 hernioplasties, 8 follow up, 1 recurrence

Secondary:

Indirect: .0 per cent

Direct: 7.4 per cent
17 hernioplasties, 14 follow-up, 1 recurrence.

CONCLUSIONS

An attempt has been made to place inguinal hernioplasty upon a rationalistic basis.

Whether the author's enthusiasm is justified, can be determined only by time and usage.

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Case Reports

A MODIFIED APPROACH IN SURGERY FOR TUBERCULOSIS OF THE ELBOW IN THE ADULT*

S. HAROLD NICKERSON, M.D.
Adjunct Attending in the Orthopedic Service, Grasslands Hospital, Valhalla, New York
WHITE PLAINS, NEW YORK

AT the onset, the author wishes to emphasize two points: (1) that the paper is restricted to consideration of tuberculosis of the elbow in adults only, and (2) that ankylosing operations for tuberculosis of the elbow in adults have been disappointing in their end results insofar as obtaining fusion is concerned.

The writer carried out a review of recent literature covering this subject and he has been left with the belief that the majority of surgeons by far favored excision of the elbow and that the treatment was definitely away from arthrodesing operations for the purpose of obtaining a cure and arrest of the tuberculous process. This situation appears to be particularly well illustrated by the remarks of Buzby[1] who states "Tuberculosis of the elbow seems the only condition where all are in accord that excision is the operation of choice."

Cleveland[2] reports five cases in which an arthrodesing operation was carried out. Of these, one resulted in bony fusion, two others resulted in pseudoarthrosis but became quiescent. In 1939, his reactions were definitely in the direction of resection considering the poor results obtained from any arthrodesing operation. Macausland[3] is of the same opinion.

Erlacher[4] described one case of tuberculosis of the elbow in which a radical extirpation of the tuberculous focus was carried out. Since this did not penetrate into the elbow joint it cannot be included in this study.

Steindler,[5] Campbell,[6] and Hallock[7] all report cases of attempts at operative fusion. All these were of the extra-articular type. Steindler used a tibial graft. Campbell described a procedure using an osteoperiosteal graft. However, he stated that he advised joint resection.

The writer has used the olecranon as the graft material in the three cases reported below. Hallock[7] described several cases in which the olecranon had been used but the writer believes that the disposition and the placement of this graft vary in certain essential details. In fact, the author is of the opinion that these variations have been definitely contributory to the good end results obtained in the cases described below.

It was believed at the time of operation that heretofore the graft had not been placed sufficiently securely into both ulna and humerus to obtain a good purchase on healthy bone above and below the elbow joint, and that this inability to hold the graft firmly in its prepared bed, so as to secure immobilization, has contributed toward unsuccessful attempts to secure fusion.

Thornton[8] described one case in which he used both olecranon and the proximal portion of the ulna as an inlay graft across the joint line. However, this type of graft, we

* From the Orthopedic Service, Dr. Win Watters, Director, Grasslands Hospital, Valhalla, New York.

believe, would be difficult to place into the elbow in any other position but extension. By using the technic described below, *olecranon are spared and remain intact on both sides.* This portion of bone is gently elevated with the proper instrument until it

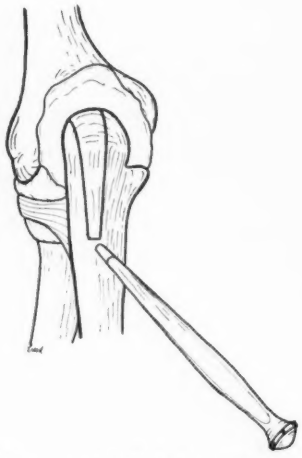

FIG. 1. A slightly wedge-shaped portion of bone is outlined on the olecranon and ulna with a thin osteotome.

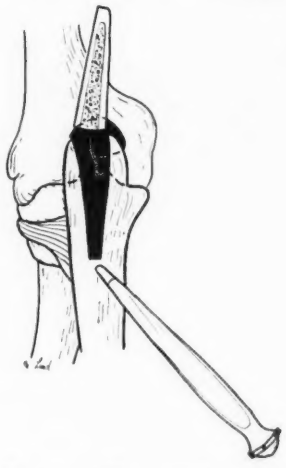

FIG. 2. The portion of olecranon is gently elevated with the proper instrument until it lies free but is still attached to the triceps.

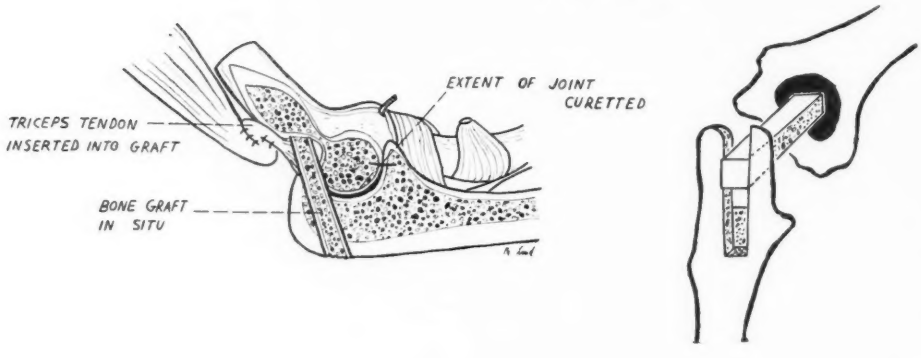

FIG. 3. A, insertion of graft. B, diagrammatic sketch to illustrate the position of the graft.

the graft fits just as well in any angle which would be comfortable for the patient.

OPERATIVE TECHNIC

With the patient lying supine and the elbow laid across the chest, a midline, posterior incision is made extending from above to four inches below the elbow with the olecranon tip about midway. The triceps and subcutaneous portion of the ulna are exposed in the midline. With a thin osteotome, a slightly wedge-shaped portion of bone is outlined on the olecranon and ulna. (Fig. 1.) *Both lateral walls of the* lies free but is still attached to the triceps. (Fig. 2.) A portion of the triceps tendon, corresponding in width to the graft which is to be used, is mobilized by two longitudinal incisions so that the graft and its attached tendon may be elevated *en masse* proximally. The elbow joint comes into view and as much diseased tissue as possible is curetted away. With this approach the ulnar nerve is well protected and does not come into view during the course of the entire operation since it has been retracted with the other soft tissues. The olecranon fossa is "fish-scaled" in its preparation for

the reception of the graft which is inserted. (Fig. 3A.) It will now be seen that the walls of the olecranon obtain a purchase on the

Fig. 4. Case 1. Preoperative *x*-ray.

graft and tend to hold it as by a pair of "ear muffs." (Fig. 3B.) The graft is now seen to be substantially entrenched across the curetted bone extending from healthy bone below to healthy bone above. The redundant triceps is plicated upon itself. (Fig. 3B.)

Both of the cases reported also exhibited involvement of the radiohumeral joint with sinuses leading from it. In each case it was decided at the time not to enter this joint surgically. This point is particularly emphasized since it was found, much to our surprise, that the sinuses closed spontaneously, and to all intents and purposes, the radiohumeral joint in both cases had progressed to a clinical cure concomitant with the degree of ankylosis obtained in the elbow joint proper. It would, therefore, appear that other surgery of the radiohumeral joint might not be necessary if complete ankylosis is obtained in the ulnohumeral joint.

CASE REPORTS

Case 1. Mr. J. V., age forty-nine, was admitted to the medical service at Grasslands Hospital for symptoms referable to the left elbow. The patient stated that he had been suffering from pain in that joint since 1936.

Fig. 5. Case 1. *X*-ray shows complete bony ankylosis.

The diagnosis of tuberculosis had been established and since that time had been treated with immobilization in plaster dressings. Repeated *x*-rays showed a progressive destruction of the elbow joint and of the radiohumeral joint. Sinuses began to appear about the elbow and had persisted up to the time of operation. The largest draining sinuses appeared opposite the radial head. On November 14, 1938, an arthrodesing operation was carried out using the technic described above. A note on August 11, 1940, stated that, "The elbow is clinically fused." He does a good day's work as a farmhand and he suffers no pain whatever. All the sinuses are closed. Pronation and supination in the forearm is about 40 per cent normal.

Case 11. Mr. V. DiL., age twenty, was originally admitted to the pediatric service at Grasslands Hospital for treatment of tuberculous polyserositis involving the pleural cavities, peritoneal cavities and apices of both lungs. From the records it appears that he was finally discharged as cured after a prolonged period of treatment. He first began to complain of the right elbow in 1937. The diagnosis of tuberculosis was made and he was treated with plaster casts. Sinuses about the elbow appeared and closed at different intervals. *X*-rays showed destruction of all joints at the elbow. Operation was carried out on November 10, 1938. A note on July 22, 1940, stated, "All sinuses are closed

about the elbow which appears clinically solid. Fifty per cent pronation and supination of the forearm remain."

FIG. 6. Case II. Preoperative *x*-ray. Note loss of radial head.

The pathological specimens in the above cases were found to exhibit, "tuberculous bone and bone marrow."

himself, after hopes of locating him were given up. The following is a brief summary of his history as taken in 1940:

FIG. 7. Case II. *X*-ray shows complete bony ankylosis.

A B

FIG. 8. A, anteroposterior view shows solid fusion of graft from ulna below to humerus above; B, lateral view shows the characteristic "tongue-like" projection formed by the graft where it is closely apposed to the humerus and ulna.

Some time after the above paper was completed, the following patient presented

CASE III. J. DiP., aged thirty-seven, had tuberculosis of the kidney about seven years

ago for which a nephrectomy had been performed. Shortly afterward tuberculous orchitis developed, and this was also treated surgically. Symptoms referable to the elbow started about four years ago. For the past two years sinuses have been draining about the elbow, and he has had splintage for the same period of time. In 1940, the range of painless motion was markedly restricted, and rotation of the forearm was reduced to about 30 per cent of normal. Using the technic described above, operation was carried out in February, 1941. Splintage was removed in April, 1942. He has a well ankylosed elbow with about the same amount of pronation-supination as described above. Only the postoperative *x*-rays taken recently are available, but these show the same characteristic "tongue" of bone, well coapted to the humerus and the ulna. (Fig. 8A and B.)

SUMMARY

1. An improvement in technic is presented for arthrodesis of the tuberculous elbow in the adult.

2. In the face of notoriously poor statistical results, this operation has been completely successful in the three cases described. Although three cases do not constitute a series, I have reason to believe that similar good results will be obtained in future cases.

3. It appears that there may be no need to attack the radiohumeral joint at the time of the operation. The sinuses may disappear spontaneously, as they did in both the above cases, if the ulnohumeral joint becomes fused.

4. It is of interest to note that the patients desired an attitude of slight extension in the elbow, as the best functional position most suitable to them in their occupations.

5. In view of the excellent results obtained by following the described technic, the writer wishes to recommend this operation to others.

The author wishes to thank Dr. J. C. McCauley, Jr., for permission to use the last mentioned case in this paper.

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MYXOMA OF THE APPENDIX*

CASE REPORT

WILLIAM R. LAIRD, M.D.
Department of Surgery,
Laird Memorial Hospital

AND

LEWIS E. NOLAN, M.D.
Director of the Tumor Clinic,
Laird Memorial Hospital

MONTGOMERY, WEST VIRGINIA

MYXOMA of the peritoneum is a rare tumor composed of mucoid tissue. It may arise as a primary tumor

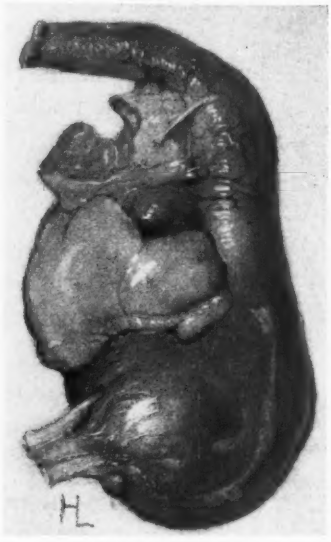

FIG. 1. Macroscopic appearance of myoma in appendiceal mesentery.

probably originating from embryonal mucoid tissue. This is found in the umbilical cord but does not appear normally in other parts of the body. The tumor is seen in connective tissue which has umdergone myxomatous metaplasia, a transformation which is considered to be a true metaplasia rather than a degeneration. Ewing refers to a pure myxoma in the mesentery observed by Borst. Woodruff and McDonald, in a study of 146 cases of benign and malignant tumors of the appendix, occurring in a series of approximately 43,000 appendectomies, observed no myxomas. A primary myxoma of the appendiceal mesentery is very rare, and the following case may be considered unusual:

CASE REPORT

A. H. N., a thirty-four year old white man, began to have abdominal pain approximately fifteen and one-half hours before admission to the hospital. The pain at its onset was aching in character, periumbilical in location; later it became intermittent, cramp-like, and colicky, and ten hours after onset localized in the right lower abdominal quadrant. The pain was associated with active nausea. There had been one similar, but less severe, attack approximately one year previously; otherwise his past history did not contribute any significant illnesses.

Physical examination revealed a well developed, well nourished, white adult male, not appearing acutely ill. The head, neck, heart and lungs were normal. The respiratory rate was 20, pulse rate 100, temperature by mouth 99.0°F., and blood pressure 124 systolic and 90 diastolic. The abdomen moved freely on respiration and there were no tympanites or excessive muscular rigidity. There was tenderness in the right lower quadrant on deep palpation. A small, firm, tender mass was palpable in the ileocecal region. Murphy's sign and the psoas test were positive.

The voided specimen of urine was straw colored, neutral in reaction, and tests for albumin, sugar and acetone were negative. Occasional erythrocytes, leucocytes and epithelial cells were observed microscopically. The blood Wassermann and Meinicke precipitation tests were negative. Blood urea nitrogen determination was 12.5 mg. per 100 cc. The total erythrocyte count was 4,800,000; hemoglobin (Sahli) 96 per cent; sedimentation time—first hour 15, second hour 40, method of Westergren; total leucocytic count 15,300; differential leucocytic count—68 per cent segmented

* From the Surgical Service and Department of Surgical Pathology, Laird Memorial Hospital, Montgomery, West Virginia.

polymorphonuclear leucocytes, 1 per cent eosinophiles, 6 per cent monocytes, 27 per cent lymphocytes. Mild toxic granulation was observed in 36 per cent of the segmented granulocytes.

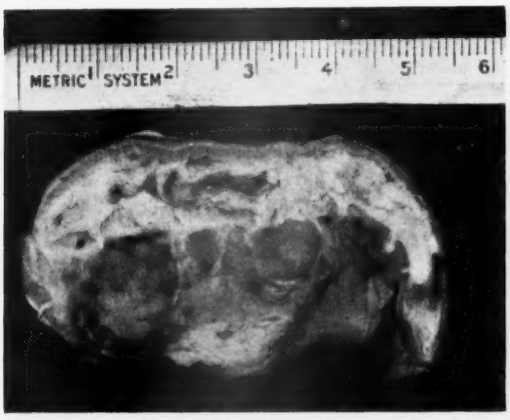

Fig. 2. Longitudinal section of appendix showing subperitoneal location of myxoma in subserosa.

With a preoperative diagnosis of acute appendicular obstruction, the abdomen was opened through a Krammerer-Jaboulay incision, four hours after admission and nineteen and one-half hours after onset of the illness. The omentum had a granular appearance. The appendix was found low. At the tip of the appendix there was a bluish mass with a diameter about one-third larger than that of an olive. In delivering the appendix the mass was ruptured. The rupture was pin-point in size and there exuded from the mass material having the general appearance of white caviar. The base of the appendix was ligated low, and the structure plus the mesentery, was excised. The stump was buried and the wound closed in the usual manner.

The wound healed per primum, and after an uncomplicated and uneventful recovery the patient was discharged from the hospital as cured on the eleventh postoperative day. He returned to his work as a salesman and to the date of this report, three years later, has been free from symptoms or physical findings of recurrence of the newgrowth.

Surgical Pathological Protocol. The specimen was a whitish-gray, vermiform appendix, measuring 6 cm. in length and 1.5 cm. in diameter. There was a reddish-gray bulbous area at the tip, measuring 2 by 5 cm., and covered with a thin layer of fibrin. Purulent exudate exuded from a small opening in the tip. On sectioning the lumen was found to be patent throughout and the mucosa smooth. There was fecal material and a small amount of exudate in the lumen. There were several encapsulated areas, 5 to 12 mm. in diameter, in the subserosal layer, which contained a gelatinous appearing substance. (Figs. 1, 2 and 3.)

Fig. 3. Internal view of appendix. Note glistening, gelatinous appearance of myxomatous tissue.

Microscopic: The lining epithelium was moderately hypertrophied. The tubular glands were short, and lined with columnar epithelium with occasional mucous droplets in the cytoplasm. The lumen contained a small amount of exudate made up largely of lymphocytes and polymorphonuclear leucocytes. The lymphoid follicles were atrophied. The tunica propria was infiltrated with numerous plasma cells and a moderate number of eosinophiles. The submucosa was increased in thickness and made up largely of fat cells and fibrous connective tissue containing scattered polymorphonuclears and lymphocytes. The subserosal layer was edematous, of increased thickness, contained perivascular infiltration of lymphocytes, and was diffusely infiltrated with polymorphonuclears, lymphocytes and plasma cells. This layer also contained areas, 5 to 12 mm. in diameter, made up of a delicate reticulum of connective tissue cells, between which there was abundant precipitated grayish basophilic mucoid material. The cells were stellate and spindle-shaped with spindle nuclei predom-

inating. The cytoplasmic processes of the cells were lost in the mucinous intercellular substance. Scattered throughout the tumor, and adjacent to it, there were numerous mononuclear cells, eosinophiles and polymorphonuclears. There was a small area of extravasation of erythrocytes in the tunica muscularis. (Figs. 4 and 5.)

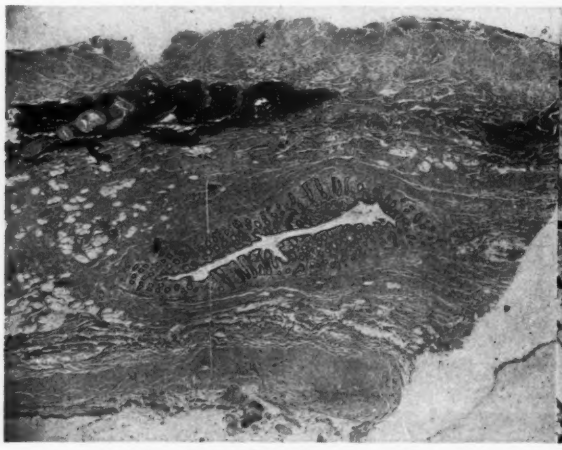

FIG. 4. Section through wall of vermiform appendix. Note atrophy of lymphoid follicles, fibrous connective tissue in thickened mucosa, and area of extravasated erythrocytes in tunica muscularis. (U. S. Army Medical Museum. Neg. No. 67969. Photomicrograph × 32.)

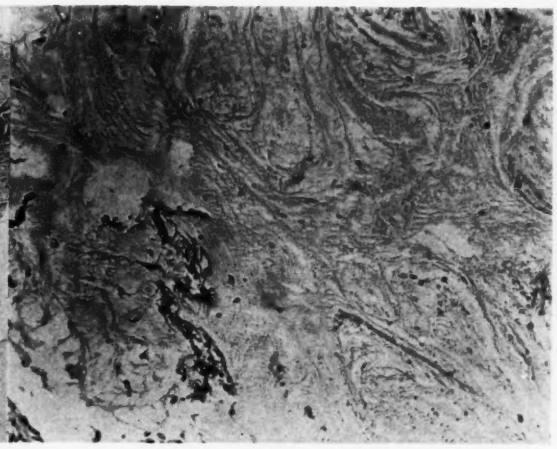

FIG. 5. Section through myxomatous connective tissue in subserosal layer of the vermiform appendix. Observe spindle and stellate cells in matrix of mucinous substance. (U. S. Army Medical Museum. Neg. No. 67968. Photomicrograph × 320.)

The material was also studied by J. E. Ash, Lieutenant-Colonel, Medical Corps, Curator, U. S. Army Medical Museum, Washington, D. C., who reported that the enlargement was due to a myxomatous type of connective tissue with involvement of the serosa, together with chronic inflammatory exudate scattered through the tumor portion. The specimen has been mounted at the Army Medical Museum, accession No. 59,985.

Histopathological Diagnoses: Myxoma—appendiceal mesentery. Appendicitis—recurrent acute.

TREATMENT

The treatment of myxoma is wide surgical excision. In this case the appendix was removed with the appendiceal mesentery containing areas of myxomatous connective tissue. The myxoma cells infiltrate the tissue widely about the primary tumor. The extent of infiltration cannot be accurately gauged from macroscopic inspection, hence a wide margin of tissue must be excised with the tumor to obtain a complete removal at the first operation. The neoplasm is not completely encapsulated and has a marked tendency to recur locally, principally because of inadequate removal, either from excision with a too narrow margin, or because of anatomical difficulty of complete removal. In the event of recurrence, the treatment indicated is further adequate surgical excision. It is imperative that the mucoid material be removed without soiling the wound, as spilling of the material results in widespread distribution of the neoplasm throughout the peritoneal cavity. Intestinal obstruction may occur many years later as a complication from peritoneal implants of myxomatous tissue.

DISCUSSION

The mucoid tissue found in a myxoma normally occurs in the umbilical cord but not in other parts of the body. A pure myxoma is readily recognized macroscopically by its slimy character and soft, moist, translucent, gelatinous appearance. It occurs in subcutaneous, subserous and intermuscular tissue. Myxomatous connective tissue in the appendix must be differentiated from mucocele of the appendix. In the latter pathologic entity the dilated appendix is filled with mucinous material. As a result of inflammation, the proximal

part of the appendix becomes completely closed and mucin accumulates and dilates the distal portion. The differentiation is made by the appearance of the lumen and the character of its content, by careful microscopic sections of material throughout different areas of the wall, and cytological study of the exudate from the lumen. Tumors of benign histologic structure often recur with areas of sarcomatous structure, hence the prognosis in myxoma should always be guarded. Such tumors are termed myxosarcoma.

CONCLUSIONS

1. A case of myxoma of the appendiceal mesentery is presented with a three-year cure after surgical treatment.

2. The treatment of myxoma of the vermiform appendix is complete surgical excision.

3. The prognosis in such tumors must be guarded because of the frequency of local recurrence, the danger of peritoneal implants of myxomatous tissue with late complication, such as intestinal obstruction and the recurrence of myxosarcoma in the case of myxomatous tumors of benign histologic structure.

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CALCIFICATION OF OVARIES

GILES A. COORS, M.D.
Assistant Professor of Surgery, University of Tennessee
MEMPHIS, TENNESSEE

CALCIFICATION of ovaries is a comparatively rare condition. Up to 1930 there had been only about nine reported cases and most of these represented calcification of a single ovary. The calcification of both ovaries is an extremely rare condition.

FIG. 1. A flat abdominal plate showing two distinctly calcified, opaque masses situated laterally in the pelvis.

FIG. 2. Lipiodal injection of the uterus showed these masses to be extra-uterine. The uterine cavity is fairly normal in size and contour.

TYPES

Calcification is especially seen in ovarian tumors, fibroids and dermoids. There is another type of calcification seen in an ovary and about the tubes. These are the concrete, isolated, discrete, laminated calcium nodules called psammoma bodies. This term was coined by Virchow in 1863 when he was writing of the presence of these bodies about the covering of the brain.

Dr. Wm. Wilson, in the *Western Journal of Surgery* in 1933, wrote extensively, citing numerous cases of psammoma bodies in ovaries and tubes.

There is another type of calcification seen in the ovary that is the calcification that occurs in healed corpus luteum cysts resulting in definite circumscribed areas where true bone formation is seen with haversian canals penetrating the calcification. These are termed corpus albicans.

The metaphysics of the calcification are both mechanical and chemical. Naturally, there is no fixed demarcation between the mechanical and chemical causes. Each produces calcification as they favor one another in a rather vicious cycle.

Dr. Eli Moschcowitz writing in 1916 in the *Bulletin of Johns Hopkins Hospital* states that the process of calcification is analogous to the normal physiological endochondral ossification, the only difference being the ossification occurring in ovaries which follows the formation of hyaline connective tissue. Dr. Moschcowitz also stated that calcification occurs only in dead tissue.

Dr. Whitridge Williams writing in the *Trans-American Gynecological Society* in 1893 believes that there occurs in the ovary a coagulative necrosis with diminishing blood supply. He also states that there are varying and intermittent amounts of

lymph and blood to the tissues promoting the formation of hyaline tissue and precipitation of lime.

Dr. Wagner believes calcium is precipitated by the stagnation of interstitial fluids.

Dr. J. M. Gamble, writing in *Chemistry and Medicine* in 1928, states and has proved to his own satisfaction from a chemical standpoint, that calcium phosphate in the blood serum is precipitated by any lowering in the carbon dioxide content of the tissue fluids. Chronic inflammation with stagnation, slowing of the blood supply and the production of local acidosis make a condition favorable for the lowering of carbon dioxide.

Dr. Hellmut Kamniker writing in 1921 states emphatically that bone formation in cartilage occurs in the ovary only in teratomas. He attempts to explain the formation of calcium by the metaplasia of the already existing cells into other cells capable of forming calcium and bone. He states that puerperal sepsis with thrombosis is likely the predisposing cause of calcified ovaries.

SYMPTOMS

The symptoms of calcification of ovaries are those that you naturally expect: (1) There is a sense of weight and fullness in the pelvis; (2) severe abberation or cessation of the menstrual cycle depending upon the amount of normal residual ovarian tissue not involved in the calcification process; and (3) the history of some preexisting pelvic infection which would tend to explain the local stagnation, hyaline degeneration and acidosis.

DIAGNOSIS

Diagnosis is confirmed by the presence of very hard unyielding parametrial body or bodies upon vaginal examination. Diagnosis is made certain by the *x*-ray examination with the finding of dense opaque bodies lateral to the uterus.*

* Further case reports on the subject have been reported by H. A. Curtis, Ivens, Margaret Salmon, T. C. Bost, and A. L. McIlroy.

CASE REPORT

This is a case of Mrs. W. H. B. age 38, white, who came in to see me stating that she believed

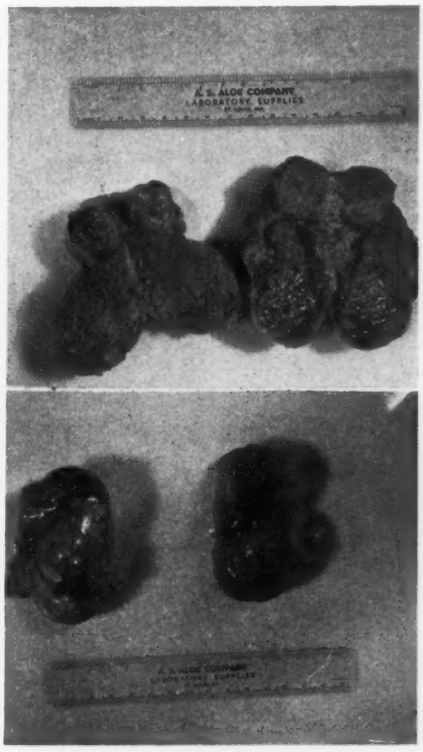

Fig. 3. Specimens consisting of both ovaries which were diseased. Both contained deposits which were stony hard in character.

that she was about eight months pregnant on account of her enlarged abdomen and almost complete cessation of menstruation for many months.

She stated that her last normal period had been nine months before and that before this her periods as she recalled, were fairly regular. Since her last normal period she had seen spotting at intervals, maybe a day or day and a half at a time, but that she had seen no normal menstruation for the last nine months.

Examination revealed a rather obese woman with the contour of the abdomen just fat and not suggesting the presence of pregnancy. There were no demonstrative breast changes and no fluid in the nipples. She was not nauseated. Palpation of her abdomen did not reveal any mass but a considerable amount of extra fascial fat. Auscultation of the abdomen revealed only what was interpreted as normal peristaltic sounds.

Vaginal examination revealed a very small cervix hard in consistency, no lacerations and only an inconsequential amount of erosion. This patient, as already stated, was very obese and on vaginal examination very hard unyielding masses could be found behind and lateral to the uterus.

A flat abdominal plate was made which showed two distinctly calcified, opaque masses situated laterally in the pelvis. (Fig. 1.) Lipiodol injection of the uterus was done and a second *x*-ray was made which showed these masses to be extra-uterine. The uterine cavity was fairly normal in size and contour. (Fig. 2.)

An operation was advised for the patient and was accepted. Preoperative diagnosis was made of calcified masses of the adnexa most probably of the ovaries and likely calcified dermoids.

At operation a uterus normal in size and shape was found, also normal tubes and a large calcified ovary on either side. The shape of these ovaries vaguely resembled the shape of a normal ovary but they had the consistency of billiard balls.

The postoperative convalescence was fairly uninterrupted and after about ten days, at which time she was in good condition, a gallbladder function test was done and was reported normal with no stones in the gallbladder. There were no stones in the urinary tract. A blood calcium was done on this patient which was 8 mm. per 100 cc. of blood. There was evidently no constitutional disturbance of calcium metabolism as 8 mm. is a low normal and she had no unusual calcification in any other portion of her body. It appears that this calcification was a localized circumscribed process in the ovary itself.

Pathological Report. Gross Appearance: The specimen (Fig. 3) consisted of both ovaries which were diseased. They both contained deposits which were stony hard in character. In some positions these deposits were yellowish and transparent, and looked very much like cholesterol. In other portions they were opaque and seemed to be composed of calcium. One ovary weighed 87 Gm. and one 96 Gm. The over-all dimensions of one ovary were 7½ by 4 by 3 cm. The Fallopian tubes were intimately attached to the masses and there was a small amount of soft ovarian tissue on one of the masses. However, for the most part the ovarian tissue had been entirely replaced by this stony hard material.

Microscopic Appearance: On section of the soft portion of one of the ovarian masses, rather normal ovarian tissue was seen. There were numerous primordial follicles. There was a well developed corpus luteum and numerous corpora albicans. There was some blood pigment scattered near the corpus luteum. The areas of calcification were bordered by fibrous tissue. The fibrous tissue around the large mass contained small specks of calcium also. There was no clue in the sections as to just what part of the ovary this calcification may have had its inception, but the end result was encapsulation by dense fibrous tissue.

Pathological Diagnosis: Bilateral calcification of ovaries.

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HEMANGIOMA OF THE STOMACH

JAMES ROBERT GLADDEN, M.D.
Assistant Resident in Surgery, Provident Hospital
BALTIMORE, MARYLAND

THIS report includes the record of one case of hemangioma of the stomach and a review of the literature concerning this condition. This case is of interest because there were no symptoms, and the tumor was accidentally found during an exploratory operation for a stab wound of the abdomen. The mass was excised and sent to the pathology laboratory for diagnosis.

CASE REPORT

C. C., aged forty, a common laborer, was admitted to the surgical service of Provident Hospital on April 22, 1941, with a history of a stab wound of his abdomen. The injury was acquired following an altercation about ten blocks from the hospital.

Immediately after examination in the accident room, the patient was placed in bed in antishock position and given treatment for shock. In less than an hour he was operated upon.

The history of patient prior to this accident was not remarkable. Not infrequently, he had suffered from pains in the epigastric area and headaches following overindulgence in alcoholic beverages. These attacks usually cleared up within twenty-four hours. There was no history of constipation, black stools or even a little blood in his stool and no history of weight loss at any time. His eyes were good, hearing was normal, appetite was good and his nose, throat, and chest except for infrequent attacks of coryza in the fall and winter seasons had caused no serious trouble. He gave a history of a gonococcal infection at age of seventeen years and again at the age of thirty-four years. In both instances, symptoms were eliminated following medical treatment.

Physical examination revealed a fairly well developed and well nourished adult negro patient. Head, neck and chest were essentially negative. The abdomen was normal in size and shape. A penetrating stab wound, with omentum protruding from same, was noted about 2 cm. to left of midline midway between xiphoid process and umbilicus. The laceration of skin was about one inch in length and horizontal in direction. Palpation about the wound showed some tenderness in both lumbar regions. No physical sign of fluid in his abdomen was noted. His skin was dark brown, smooth, moist, and showed a number of healed scars over the extremities. No nevi or otherwise unusual lesions were noted.

Blood count showed 4,200,000 red cells and 11,850 white cells per cmm. with 88 per cent hemoglobin. The Wassermann reaction of the blood was positive. Except for traces of albumin and sugar urinalysis was essentially negative. (Test made after infusion of glucose and normal saline.)

At operation a lengthy midline incision was made for exploration of abdominal contents. A laceration of the omentum near the greater curvature of stomach close to pylorus, and two small lacerations of jejunum were repaired. A protruding, palpable, prominent bluish-red mass about the size of a small marble, and covered by an apparently normal serosa, was noted on anterior surface of the stomach. This mass was near the greater curvature in the pyloric portion of the stomach. The tumor mass was excised and the operative wounds were closed in the accepted manner. No diagnosis of the type of tumor was attempted prior to time the specimen reached the pathological laboratory. Lymph glands were normal and no pathological changes were noted in any of the abdominal viscera examined during the operation. The patient had an uneventful convalescence and left the hospital on May 1st. He was last seen twenty-five days after the operation, at which time he was in the best of health and offered no complaints.

Pathological Report. The specimen consisted of a small mass removed in an elliptical manner, about the size of a small marble and covered by two well defined layers of tissue. A light bluish-red color was noted over both surfaces about the firm, spherical and somewhat movable inner mass. Section revealed

definite outer layers surrounding a circumscribed bluish-red, gelatinous-like rounded mass of tissue with a diameter of 1 cm. A

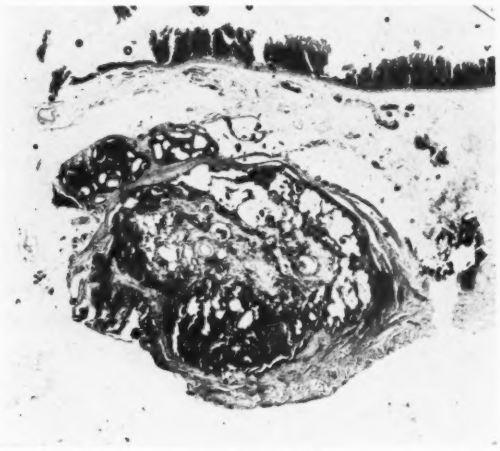

FIG. 1. Photomicrograph showing section of the hemangioma in the muscular wall of the stomach. The mucosa of the stomach is at the top and is distinct. The cavernous spaces in the tumor mass are outstanding and the tumor can be seen to invade the subserosa below. × 8.

sanguineous fluid exuded from the cut surface.

Microscopic Examination. The mucous membrane of the stomach was normal throughout. The growth was in the muscular wall and extended through to the submucosa. It was characterized by capillary walls lined by endothelium. The area was supported by proliferating endothelium in which there were many lymphocytes and large monocytes most of which contained blood pigment. There were a few polymorphonuclears and proliferating fibroblasts present.

Diagnosis: Cavernous hemangioma in the muscular layers of the stomach wall.

COMMENT

A hemangioma is a tumor produced by a new formation of blood vessels. It is quite common in some locations and is usually called an angioma. Two types are usually seen: the capillary and the cavernous. Cavernous hemangiomas are less common, having the same structure as erectile tissue, and are composed of large blood spaces or sinusoids lined by endothelium. It is extremely rare to find a tumor showing a complete cavernous change. In almost all reported cases if the cavernous hemangioma is present, it is associated with the capillary type with varying changes in transition between the two.

In reviewing the literature, it is obvious

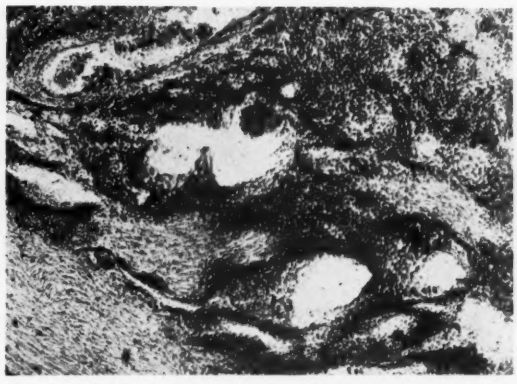

FIG. 2. Photomicrograph of the hemangioma showing more in detail the cavernous spaces. × 100.

that benign tumors of the stomach are infrequent, and that vascular tumors are especially rare in this group. Lemon, in 1920, reported one case of angioma of the stomach to add to the five of which he had knowledge, namely, the cases reported by Guisez, Stockis, Burty, Lammers, and one by Sherril and Graves. Kornmann, in 1913, stated that hemangioma constituted only 7 per cent of all benign tumors of the entire gastrointestinal tract.

Balfour and Henderson, in 1927, published a report on a study of fifty-eight cases of benign tumors of the stomach that had come up for operation at the Mayo Clinic up to the time the article was written. In this series there were only four cases of hemangioma of the stomach. Three of the four patients with hemangioma had suffered from slight dyspepsia and a fourth from recurring attacks of diarrhea. The outstanding features of this group, however, were the previous occurrence of melena in three cases and of severe hematemesis in one. In only one case was gastric acidity abnormal; there was no free hydrochloric acid. The hemoglobin in two of the cases was 44 and 47 per cent, respectively. The tumors varied from 2.5 to 6 cm. in diameter, and the largest weighted 108 Gm. They were all single and pedunculated. Two were ulcerated and none had undergone malignant degeneration.

McClure and Ellis, in 1930, published the records of twenty-five patients who had been found to have hemangioma of the gastrointestinal tract. Of these, fourteen were single and eleven multiple. There were no cases of hemangioma of the stomach in this group. The records of two additional patients and a complete review of the literature were published by Kaijser in 1936. He classified seventy-four verified instances of hemangioma of the gastrointestinal tract into five groups, which may be summarized as in the accompanying Table 1. (From Pierose's report of hemangioma of the gastrointestinal tract.)

TABLE I

CLASSIFICATION BY KAIJSER OF VERIFIED INSTANCES OF HEMANGIOMA OF GASTROINTESTINAL TRACT

Classification (Kaijser)	Pinpoint Multiple Varicosities	Diffuse Infiltrating Cavernous Hemangioma	Circumscribed Cavernous Polypoid Hemangioma	Hemangioma Simplex (Telangiectasis)	Hemangiomatosis
Group	I	II	III	IV	V
Sex	24M 3F	14M 8F	5M 5F	5M 2F	2M 5F; 1?
Age variation	26–79	3 mo.–48 yr.	15–62	3 mo.–64 yr.	2 mo.–61 yr.
Location					
Esophagus	2	1			
Stomach	2	..	..	2	2
Duodenum	..	..	..	2	
Jejunum	9	..	..	1	
Ileum	7	..	..	1	
Meckel's diverticulum	..	..	1		
Small intestine	..	7	4	1	3
Cecum	..	..	..	1	1
Sigmoid flexure	..	7	1		
Rectum	3	12	3		
Large intestine	9	..	..	..	2
Gastrointestinal tract	..	..	1	..	6
Total cases	27	22	10	7	8

Ewing refers to Kaijser's "hemangioma simplex" group as being synonymous with "telangiectasis." Kaijser also included a fifth group in his classification, "hemangiomatosis." Cases under this classification presented hemangiomas in other organs in addition to those found in the gastrointestinal tract.

Minnes and Geschickter, in 1936, published an article reviewing the literature of benign tumors of the stomach and presented the clinical and pathological features of fifty benign tumors of the stomach recorded in the Johns Hopkins Hospital from 1889 to September 1936. According to the tissue of origin they divided the tumors into two groups: epithelial and mesenchymal. Among the epithelial tumors were adenomas, adenopapillomas, adenomyomas and fibroadenoma. Chief among the mesenchymal tumors were the leiomyomas, fibromas, lipomas, neurofibromas and the rare angiomas and osteomas. According to their report hemangiomas are rare. Ten had been collected by Eliason and Wright, to which five more recent cases were added. In the series of fifty cases reported by Minnes and Geschickter, there was only one case of hemangioma. In regard to the mesenchymal tumors, the latter authors state that they may be sessile or pedunculated. They lie within the wall of the stomach, project into its lumen or remain subserous and project into the peritoneal cavity. They are usually

small but sometimes grow to tremendous size. Occasionally, by virtue of their size and position, they cause embarrassment of the circulation to the supra-adjacent mucosa, resulting in necrosis and ulceration. Rarely do they undergo hyaline, cystic or malignant change.

TABLE II
INCIDENCE OF BENIGN TUMORS OF THE STOMACH GATHERED FROM THE LITERATURE BY MINNES AND GESCHICKTER

	No.	Per Cent
Epithelial		
Polyps	182	19.5
Papillomas	89	9.5
Adenomas	42	4.5
Polyposis	16	1.7
Mesenchymal		
Leiomyomas	341	36.6
Neurofibromas	102	10.9
Fibromas	42	4.5
Lipomas	32	3.4
Osteomas	1	0.1
Osteochondromas	1	0.1
Myomas	3	0.3
Endothelial		
Hemangiomas	15	1.6
Lymphadenomas	14	1.5
Endotheliomas	12	1.2
Cysts		
Simple	29	3.2
Dermoid	5	0.5
Echinococcic	4	0.4
Total	931	

SUMMARY AND CONCLUSION

A patient came to accident room of hospital with the complaint of a stab wound of the abdomen. During the operation a small bluish area projecting from the serosal surface of the stomach was excised. A pathological diagnosis of cavernous hemangioma of stomach was made. There was no history of any symptoms in relation to the tumor.

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LEIOMYOMA OF THE SPERMATIC CORD

CASE REPORT

WALTER W. McCOOK, M.D.*
FORT BRAGG, NORTH CAROLINA

LEIOMYOMA appears to be one of the rarest of a small group of neoplasms arising from the structures of the spermatic cord. Schulte, McDonald and Priestly,[1] in 1939, reviewed all reported cases of tumors of the spermatic cord and found only three leiomyomas out of a total of 247 tumors. They also list two cases of leiomyosarcoma one of which was reported by Thompson[2] in 1936. This tumor appeared histologically to be myoma but, because of repeated recurrences, was classed as leiomyosarcoma.

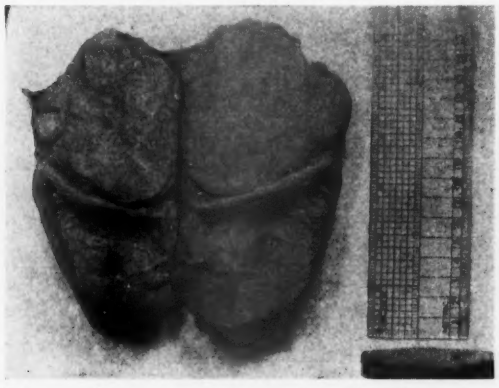

FIG. 1. Gross appearance of sectioned tumor. The tumor appears at the top, the testicle at the bottom and the hydrocoele between.

The following case report is of interest due to its rarity, its comparatively large size, and its coincident association with a hydrocele which led to an erroneous preoperative diagnosis:

CASE REPORT

A sixty-six year old colored male was admitted to the urological service on August 19, 1938, with the chief complaint of a swelling of the right side of the scrotum. There had been a gradual increase in size of a painless mass in the right side of his scrotum for a period of one year. One week before admission the mass had been aspirated and a large quantity of thin, watery fluid removed.

Examination revealed a mass in the right side of his scrotum measuring 11 by 15 cm. The mass was slightly tender and the skin over it was edematous, thickened and indurated. It did not transmit light and was irreducible. A diagnosis of hydrocoele was made and 120 cc. of straw colored fluid aspirated. A right orchidectomy was performed five days later with ligation of the spermatic cord at the internal ring. Convalescence was uneventful and the patient was discharged on the twelfth postoperative day.

FIG. 2. Photomicrograph showing intertwining bundles of smooth muscle.

Pathology. The specimen was an elongated mass measuring 18 cm. in length and 10 cm. at its greatest width. Its external surface showed fibrous strands which represented adhesions separated at operation. On section three sharply separated masses were found which presented widely different gross features. At one extremity a testicle measuring 4.5 cm. presented no unusual characteristics except edema. The seminiferous tubules could be easily extracted. At the upper extremity of the testicle occupying the position of the epididymis there was a pinkish, edematous, fleshy mass measuring 2.5 cm. At the opposite extremity of the mass was an ovoid, solid circumscribed tumor measuring 10 cm. in diameter. On section its

* Former Junior Resident Surgeon, Shreveport Charity Hospital, Shreveport, Louisiana.

pinkish-white surfaces bulged and presented a series of nodules measuring from 1 to 4 cm. in diameter. These latter were separated by broad zones of wet semitranslucent tissue in which one detected evidence of intertwining. A middle triangular, cystic structure measuring 8 cm. in its greatest width was filled with greenish fibrin that was saturated with fluid of a similar color. This appeared to be enclosed by the thickened tunic and its lining was red and granular.

Microscopically, the tumor was composed of typical smooth muscle cells arranged in whorls with interlacing bands between of similar tissue. There were diffusely scattered nodules of almost pure smooth muscle tissue. The connective tissue scattered between the muscle cells was not a predominant feature. The tumor had an appearance identical with that of a leiomyoma of the uterus. The testicle showed only edema. The epithelial lining of the hydrocoele was absent, being replaced by granulation tissue covered with fibrin.

SUMMARY

A case of leiomyoma of the spermatic cord is reported occurring in a sixty-six year-old colored male. The only symptoms were a painless mass that gradually increased in size over a period of one year. The association of a hydrocoele, proved by aspiration, led to an erroneous diagnosis. The tumor was 10 cm. in diameter and had the appearance of a uterine leiomyoma. This is believed to be the largest such tumor reported and is the fourth one found in the literature.

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PRIMARY NEUROGENIC SARCOMA OF THE FOREARM FOLLOWING TRAUMA AT GOLF

CASE REPORT

SAUL ALFRED RITTER, M.D.
Assistant Attending Surgeon, Misericordia Hospital
NEW YORK, NEW YORK

ISOLATED solitary neurogenic sarcoma of peripheral nerves unassociated with von Recklinghausen's disease is uncommon. Its occurrence is even more unusual following a definite history of trauma.

The accessibility of these tumors generally leads one to minimize their serious nature and most often to mistake them for benign growths. It is rarely diagnosed as malignant until pathological examination has been made and in many cases, the tumor small or large is removed without considering the necessity for radical extirpation at the time.

It is difficult to determine whether these isolated growths arise from the neurilemma, perineurium or epineurium, but the connective tissue nature of these growths make it probable that they originate from either of these structures.[1]

Stout[2] maintains that there are two classes of malignant tumors that develop in peripheral nerves; those of mesoblastic origin and those derived from neuro-epithelium.

Penfield[3] and Mallory[4] believe that these tumors arise from the supporting endoneural connective tissue and are, therefore, of mesodermal origin.

Masson[5] and Verocay[6] are of the opinion that the majority of these neoplasms originate from the Schwann cells of nerve sheaths, which have their anlage from the neural crest, hence are of ectodermal origin.

Neurofibrosarcoma usually develops in superficial and deep nerve trunks. The tumors are composed of varying numbers and sizes of cells, the more cellular forms being the more malignant.

Quick and Cutler[7] have graded these tumors into three different varieties, designating Grade I, II and III, depending on their cellular content. The more acellular group I, being the more benign type and grade III, being the most malignant.

FIG. 1. Volar-lateral aspect of left forearm showing area excised and covered by a Wolf skin graft.

Fischer,[8] in 1927, reviewed the literature on von Recklinghausen's disease, and of the 466 cases reported up to that time found that 13 per cent were complicated by sarcomatous degeneration in the nerve tumors.

Garrè[9] studied the differences between primary sarcomas of nerves and secondary sarcomas complicating pre-existing von Recklinghausen's disease and found the latter more prone to remain encapsulated for longer periods of time. He reported the former to be of greater malignancy and metastasize earlier to internal organs.

Quick and Cutler,[7] reported that fourteen patients out of seventy two with neurogenic sarcoma unassociated with von Recklinghausen's disease, gave a history of trauma, but stress that they believe that chronic irritation or repeated traumatic insults are more important if trauma as an etiology can be considered.

Stewart and Copeland,[10] on the other hand, record eight instances of trauma among their eighty-three cases, but they believe "in no case is the analysis sufficient to make the traumatic etiology secure beyond doubt."

Cramer,[11] in 1929, showed that chronic irritation by tar painting produced this form of tumor which recurred after excision.

Biggs[12] reported the occurrence of a neurosarcoma of the median nerve of the arm due to definite trauma two years before.

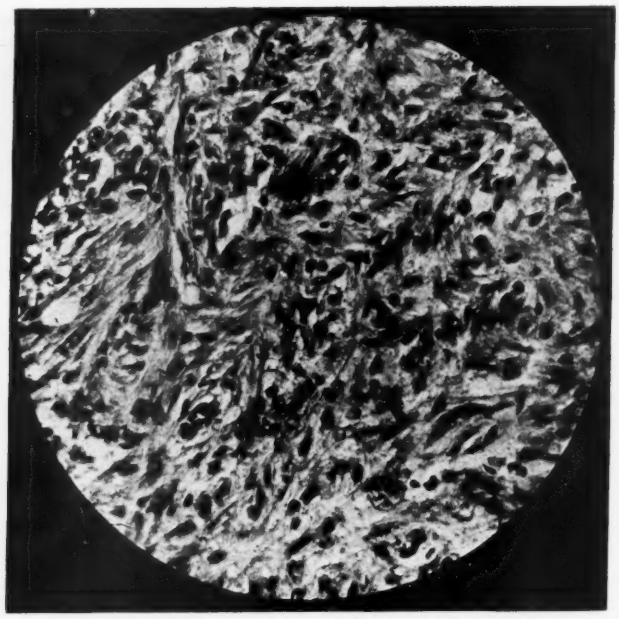

Fig. 2. Illustration showing a spindle cell sarcoma with considerable mucoid degeneration between the cells. Mitotic figures are not abundant. The arrangement of the cells very strongly suggests a neurogenic sarcoma and several nerve bundles, present in the substance of the tumor, are suggestive of the site of origin for the neoplasm.

Most authors insist that radical one-stage wide excision or amputation should be performed and unless complete extirpation is done early, there is great danger of recurrence and metastasis. Many authors on this subject point to the relative rarity of the neurogenic sarcomas and their benign appearance and that the general surgeon does not encounter them frequently enough to be familiar with their highly malignant nature.

Quick and Cutler[7] out of twenty-four cases had a mortality (exclusive of tumors of the thigh) of 50 per cent from metastases. Of the cases of tumors of the thigh the result was still worse; only two out of fifteen are still living from three to nine years after operation. Twenty per cent of all their patients with neurogenic sarcoma died from pulmonary metastases.

The case of solitary neurogenic sarcoma of the forearm which I wish to report is unique and significant. It followed a

definite trauma to the left forearm while the patient was playing golf.

CASE REPORT

M. B., twenty-five years of age, American, complained of pain and swelling on the volar aspect of the left forearm, since striking it with the end of a golf club while driving a golf ball five weeks before. He experienced pains in the flexor aspect of the left forearm which radiated up to the arm and down to the fingers. At first he paid little attention to the injury. He did notice, however, the development of a small nodule on the volar aspect of the forearm. It was painful and tender.

Upon examination, I found at the volar surface of the left forearm four inches proximal to the wrist joint, a firm, tender, subcutaneous tumor, the size of a small hazel nut. It was fixed to the underlying tissues but the skin over it was freely movable. There was no adenopathy of the epitrochlear, axillary, subclavicular or cervical glands.

On October 15, 1938, under local anesthesia, a biopsy of the growth was made. The specimen was submitted for pathological examination to Dr. R. C. Scleussner who reported spindle cell sarcoma. Sections were reviewed by Dr. Francis Carter Wood, Dr. Paul Klemperer and Dr. H. R. Muller who confirmed the pathological findings of spindle cell sarcoma of neurogenic origin.

On November 3, 1938, at Doctors Hospital, I performed a wide excision of the tissues of the volar-lateral region of the forearm, encircling the site of the biopsy. The oval area excised measured 3½ by 10 inches. It included the skin, superficial fascia and nerves, deep fascia and a portion of the muscular tissue at the site of the tumor. It was excised *en masse*. There were gray strands of neoplastic tissue invading the deep fascia at the site of the tumor.

A Wolf skin graft was removed from the proximal aspect of the left thigh and grafted over the exposed region of the forearm. It was sutured by fine silk interrupted atraumatic sutures. A splint was applied to the posterior aspect of the arm which was flexed at right angles.

The Wolf skin graft healed completely within two weeks with the exception of a few small hemorrhagic blebs which became necrotic. These areas were later covered with small Thiersch grafts. Complete healing resulted shortly thereafter. The skin over the operated area became pigmented but was elastic and freely movable. There were no adhesions between the original skin graft and the flexor tendons of the forearm. There was full mobility of the fingers and wrist.

Two and a half years after operation, the patient has some periodic neuralgic pains in the left forearm. There remains cutaneous anesthesia over the grafted area, but he has normal use of the limb.

Roentgen ray examination of the bones of the body does not reveal any metastases. There is no adenopathy and the patient is in apparent good health.

SUMMARY

1. A unique case of solitary neurogenic sarcoma of the left forearm, following a definite history of trauma at golf, is reported.

2. An early biopsy and radical excision were performed.

3. Two and a half years following operation there is no evidence of metastases.

4. No postoperative radiation was administered because of insensitivity of this neoplasm to radiation.

5. Early recognition and radical extirpation of neurogenic spindle cell sarcoma of a limb seem to obviate the necessity for amputation in these highly malignant lesions.

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PAPILLARY ADENOCYSTOMA LYMPHOMATOSUM OF THE NECK*

JOSEPH A. TUTA, M.D. AND GEORGE L. APFELBACH, M.D.
Associate in Pathology, University of Illinois College of Medicine
Assistant Professor of Surgery, Northwestern University Medical School
CHICAGO, ILLINOIS

ONE of the tumors infrequently encountered in the region of the salivary glands is the papillary adenocystoma lymphomatosum, sometimes called an adenolymphoma or onkocytoma. The histologic structure is very characteristic and is easily recognized by the peculiar tall columnar epithelium and the lymphoid stroma. Papillary formations may or may not be present.

FIG. 1. The tall, columnar cells are shown with nuclei arranged at the same distance from the inner margin. The basal row of cells is seen in some areas and also a lymph follicle with a prominent secondary nodule. Hemalum and eosin. × 160.

Carmichael, Davie and Stewart[1] in 1935, described eight cases and reviewed the literature. They were able to find only two instances which were considered malignant. In 1937, Harris[4] reported two cases making a total of forty-one known tumors. Freshman and Kurland[2] in 1938 found a total of fifty-four cases reported in the literature.

The tumor is usually a slowly growing, painless nodule. The most common location is on the outer aspect of the parotid gland. Several cases have been found behind or below the angle of the jaw and a few in relation to the submaxillary gland. The tumor has been found in much greater predominance in males. The age incidence is chiefly between forty-five and seventy years of age. Two tumors have been found in children, one at two and one-half years of age and the other at twelve years of age.

CASE REPORT

A white male, forty-eight years of age, had been aware of a slowly growing lump in his neck for one month. It was located in the subcutaneous tissue behind the angle of the jaw on the left side, and at the anterior border of the sternocleidomastoid muscle. The mass was freely movable and was removed without difficulty.

The gross specimen consisted of a soft lobulated cystic mass measuring 15 by 14 by 12 mm. The cut section showed a central cavity containing pale yellow, viscid fluid. There were numerous intracystic papillary formations some of which contained minute cysts.

Histologic Description. The tumor consisted of tubular alveoli and irregular cystic spaces with numerous intracystic papillary formations. These structures were lined by epithelium consisting in most places of two layers of cells,

* From the Grant Hospital of Chicago, the Department of Pathology of the University of Illinois College of Medicine and the Department of Surgery of Northwestern University Medical School.

an inner row of high columnar cells and a basal layer. The inner, tall, columnar cells had round or oval nuclei containing fine chromatin granules and finely granular eosinophilic cytoplasm. The nuclei were situated at approximately the same distance from the free surface. (Fig. 1.) The cytoplasm of some of the columnar cells was reduced in amount and contained large granules which stained deeply with eosin. These cells contained small pyknotic nuclei. Adjacent to these shrunken cells were clear spaces which broke the continuity of the free epithelial surface. Heidenhain's iron hematoxylin and Mallory's phosphotungstic acid stains showed the darker staining cells with much greater contrast than when stained by the ordinary hematoxylin and eosin stain. These cells were interpreted as undergoing degenerative changes. No cilia or blepharoplasten could be seen. The basal row contained fewer cells than the inner tall columnar layer. (Figs. 2 and 3.)

Fig. 2. The papillary formations are shown with the tall columnar cells replaced in some areas by narrow, darker staining cells. Phosphotungstic acid hematoxylin stain. × 160.

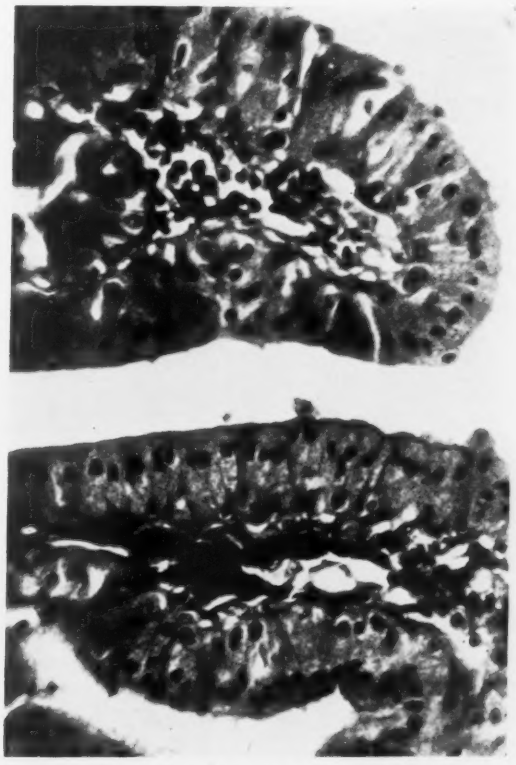

Fig. 3. The tall columnar cells and the incomplete basal layer of cells is shown under high magnification. Phosphotungstic acid hematoxylin stain. × 600.

COMMENT

The origin of the tumor has been the subject of considerable discussion. The studies of Hamperl[3] later amplified by Jaffé[5] resulted in the introduction of the term "onkocytoma." Hamperl called attention to a peculiar type of cell which he found in material from the sublingual and submaxillary glands and also from the uvula and palate. He noted the resemblance between these cells and the epithelium which had been previously described in tumor formations located in the region of the salivary glands. Harris[4] discussed the relationship of the "onkocytes" to the formation of tumor masses with similar epithelial elements and concluded that the origin of the tumor cells has not been proved to be from the onkocytes. He stated that the most acceptable theory of the origin of the tumor is from heterotopic salivary gland epithelium in lymphoid tissue. A branchiogenic origin has been held by several investigators.

SUMMARY

A case of papillary adenolymphomatous and cystic tumor of the neck is reported. It

arose in the neck below the angle of the jaw and was removed surgically with ease. The tumor is readily diagnosed histologically because of the peculiar tall, columnar epithelium and lymphoid stroma. The tumors are of interest to the clinician and pathologist since after a tumor has been recognized as belonging in this category, the patient may be reassured that a recurrence is much less likely to appear than with other types of tumors involving the salivary glands.

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When one is confronted by a simple colloid goiter of any age the possibilities exist that it is doing one of three things: nothing; becoming toxic; or degenerating and already cardiotoxic. When the goiter is doing nothing it speaks the language of a small boy; it has not yet done anything that can be discovered.

From—"Diseases of the Thyroid Gland. Presenting the Experience of More Than Forty Years"—by Arthur E. Hertzler (Paul B. Hoeber, Inc.).

THE COURSE OF CARCINOMA OF THE THYROID GLAND*

REPORT OF AN UNUSUAL CASE

HERBERT T. WIKLE, M.D. AND ALBERT J. RITZMANN, M.D.
Attending Surgeon, Cumberland Hospital — Assistant Surgeon, Cumberland Hospital
BROOKLYN, NEW YORK

THE present case of diffuse type of adenocarcinoma of the thyroid gland afforded the opportunity of studying, from the histological standpoint, not only the original tumor, but also the unhindered course of the remnants following its radical removal. Structurally, the tumor presents glandular elements of an undoubted carcinomatous nature together with cells having the appearance and arrangement suggestive of a sarcoma. An outstanding feature is the production of an enormous amount of hyaline material. Clinically, the case is of interest with respect to the age and condition of the patient and the size, position and growth of the tumor.

Neoplastic tumors of the thyroid gland are not too uncommon, although the exact incidence of malignancy is not known. In Switzerland, Wegelin[1] found one case of carcinoma of the thyroid gland in every ninety-six postmortem examinations. In the United States, carcinoma occurs about once in 928 autopsies.[2] Most clinics report an incidence of malignancy of about 1 per cent of all cases of goiter that come to operation and of 3 per cent of all adenomatous glands that are operated upon.[2,3] Nearly all malignancies of the thyroid gland are of epithelial origin and are for the most part of relatively low-grade malignancy. The majority are considered to arise from a gland having adenomatous changes. Occasionally, cancer develops in a gland considered normal or nongoitrous or in a hyperplastic gland of the exophthalmic type.

Sarcoma of the thyroid gland has been described by various authors.[4–8] However, actual acceptance of the true sarcomatous nature and connective tissue origin of a tumor of the thyroid gland is not so widely acknowledged. It is well known that the cells of a carcinoma may in part resemble

FIG. 1. Patient, age eighty-one, before first operation.

sarcoma. This holds true especially in tumors primarily of the higher grades of malignancy in which the follicular structure is less, or, perhaps less frequent than in tumors of the lower grades of malignancy in which smaller, more localized areas secondarily undergo changes indicative of increased malignancy and display cells of such shape and appearance that make their differentiation from sarcomatous cells difficult. The present case is an example of this type. Ewing, after a critical analysis of the subject of sarcomas of the thyroid gland, concludes "that the mesoblastic origin of most of the sarcomas reported in the

* Read before the Brooklyn Surgical Society, May 2, 1940.

literature is highly improbable and that the occurrence of true sarcoma in man still requires demonstration."[9]

FIG. 2. Operative specimen 1; anterior view.

FIG. 3. Operative specimen 1; halved frontally, the surface is glistening, whitish and relatively uniform. The tumor was marble-like in appearance and almost cartilaginous in hardness. The appearance and consistency are due to the presence of the great amount of hyaline.

The diagnosis of carcinoma of the thyroid gland may be difficult at times. In general, any thyroid gland with known adenomatous changes displaying recent, evident increase in size, however small, should be regarded with suspicion. Many thyroid surgeons regard the mere presence of adenomatous changes in the thyroid gland as indicative of potential malignancy. Pain, tenderness to local pressure, increase in local firmness and irregularity of the surface, metastasis to adjacent lymph-nodes, pressure symptoms, capsular and contiguous tissue invasions are all usually relatively late manifestations. Constitutional findings are infrequent except in the late stages.

CASE REPORT

The present case deals with a piano-tuner, G. C., age eighty-one, who was admitted to the Cumberland Hospital on September 29, 1939, with complaints of swelling of the neck and difficulty in breathing.

As to the family history, the father died of "lymphoma" of the thyroid gland at the age of fifty-nine. One married daughter has carcinoma of both breasts at present.

In the past the patient had gonorrhea on two occasions as a young man. He has suffered with a diverticulosis of the bladder for the past fifteen years. Self-catheterization, four times daily, had been practiced for eight years because spontaneous voiding was not possible.

With respect to the present illness, the patient noticed the appearance and gradual increase in size of a mass in the neck on the left side following a "severe nervous strain" about five years ago. It was not possible to determine whether a thyroid enlargement or a mass were present before that time. Beginning two years ago, hoarseness and difficulty in breathing were experienced. More recently, flexion of the head on the neck became limited because of the size of the tumor. There was no apparent local neck or chest pain. A mild, dry, irritative cough was present. Liquids and soft foods were swallowed more easily than dry, solid food. A loss of twenty pounds, attributable by the patient to limited food intake, occurred over the past two years. At no time in the past was there evidence of myocardial insufficiency. Lugol's solution, 2 m. daily, beginning three years ago, was taken up to three months ago.

On physical examination, there was seen a thin, poorly nourished, old man with a dry, wrinkled skin. Horner's syndrome was present on the right. The voice was hoarse and low pitched. In the neck, a 23 cm. wide, very hard, irregularly-shaped, grossly lobulated mass was found arising from the left lobe of the thyroid gland. (Fig. 1.) It extended roughly from ear to ear and from chin to manubrium. Because of its origin, size and firmly fixed position, it displaced markedly to the right the deeper midline structures, namely, the trachea and thyroid cartilage. The lateral edge of the hyoid bone could be felt directly under the right mandible at the angle of the jaw. The skin was slightly shiftable over the mass. The veins of the skin over the upper portion of the chest were prominent.

The mass overhung the manubrium anteriorly and limited somewhat the movement of the head on the neck, both vertically and laterally. An audible, low pitched stridor was heard on breathing through the open mouth. There was no tumor pulsation, tenderness or pain. Breathing difficulty was exaggerated by light, lateral pressure on the tumor. The chest was clear and the heart was markedly enlarged to the left. There were no murmurs and the rhythm was totally irregular. Extrasystoles were frequent. There was a definite pulse deficit. The abdomen presented no abnormal findings. There was present also a hypospadias and a moderately sized left, indirect, inguinal hernia. There was no ankle edema.

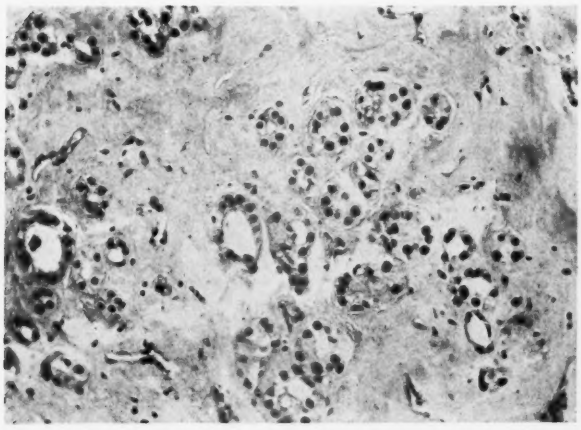

Fig. 4. A small area from the more central portion of operative specimen 1. This section was chosen to illustrate the process of coagulative necrosis and hyaline formation; careful scrutiny reveals numerous shadow forms of degenerating acini and cells. Other areas displayed a still greater degree of hyaline formation; peripherally the tumor acini were arranged in columns with broad, intervening hyaline areas. This glandular type of tissue and the hyaline material composed practically the entire bulk of the specimen. Reduced from a photomicrograph having a magnification of 300; hematoxylin and eosin stain.

Laboratory data:

Temperature: 98°F.
Pulse: apical 124.
radial 110.
Respirations: 20.
Red blood cells: 4,100,000
White blood cells: 6,800
Polymorphonuclears: 70 per cent
Lymphocytes: 26 per cent
Monocytes: 4 per cent
Wassermann: Negative
Urine: occult white blood cells; faint trace of albumen
Blood chemistry: normal
Basal metabolic rate: Plus 21.8; weight: 117½ pounds.

X-rays of the chest and neck areas displayed a flattened, displaced trachea in addition to several calcified areas in the lowermost portions of the above described mass. A cystogram showed "a large, definitely trabeculated bladder with numerous diverticuli." There were no demonstrable pulmonary, rib or spine metastases.

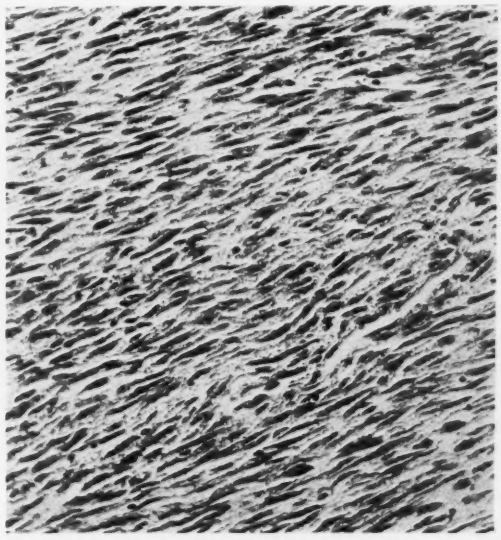

Fig. 5. Section taken from one of the occasional small areas of operative specimen 1 showing densely packed spindle-shaped cells arranged longitudinally. This type of tissue, with cells definitely more embryonal and hyperplastic in appearance. Reduced from a photomicrograph with a magnification of 300; hematoxylin and eosin stain.

Following preliminary digitalization of the patient, the tumor was removed under intratracheal, cyclopropane anesthesia. Five hundred cc. of saline and 500 cc. of blood were infused during the operation. Throughout the operation the pulse rate was around 88, although the rhythm was mildly irregular; the blood pressure maintained at 120/80; its variation was negligible. The new growth was found to involve the left lobe of the thyroid gland; its lower third extended beneath the sternum and into the left chest. The trachea was markedly compressed and displaced to the right. The left sternocleidomastoid muscle was greatly thinned out and barely identifiable. Generally, the structures contiguous to the neoplasm were invaded by it and firmly adherent to it. Sharp dissection was needed in the main for the removal of the mass. At the end of the operation the midline structures had assumed a more normal position. A forty-

eight-hour iodoform wick was inserted in the depths of the wound. There was no breathing difficulty at any time during the operation;

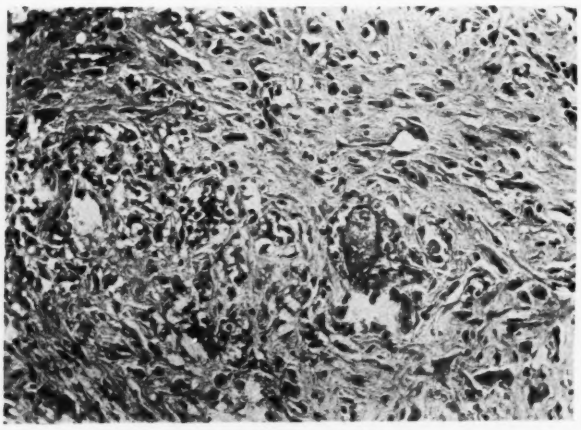

Fig. 6. Section of the single small area of operative specimen 1 displaying relatively widely separated cells of varying sizes and shapes suggestive of a mixed cell sarcoma. Just to the right of the center is a large irregularly formed acinous with eosinophilic staining colloid content.

the intratracheal tube was withdrawn about an hour after the completion of the operation.

Grossly, the removed tumor was roughly heart-shaped, measured 23 by 10 by 7 cm. and presented several large, irregular outgrowths, each of which displayed numerous smaller lobulations. (Fig. 2.) The tumor as a whole was very hard, unyielding and of an almost cartilaginous consistency. Numerous thin, shred-like tags of adjacent tissue were found to be firmly adherent to its surface. In its lower third an irregular, fairly well defined depression anteriorly divided the upper two-thirds from the lower third and roughly marked off the upper portion from the lower retrosternal third. On cutting the specimen in half, the sectioning knife met with a firm, cartilaginous-like resistance throughout the entire thickness. The cut surface was yellowish-white and presented a fairly homogeneous, glistening, somewhat opaque appearance with an occasional dull-reddish, soft area. (Fig. 3.) In the lowermost portions of the tumor several 1 to 2 cm. calcified areas were found.

Briefly described histologically, the tumor as a whole presented the picture of a diffuse adenocarcinoma of mild degree of malignancy. (Fig. 4.) Occasional small areas displayed dense collections of spindle cells. (Fig. 5.) The outstanding feature was the production of an enormous amount of hyaline material in the presence of a widespread, degenerative, coagulation necrosis.

Described in greater detail, the sections taken from representative portions of the tumor presented some variations as to the appearance of the acini, although in the main, they were small, relatively well rounded and somewhat closely packed, one to another; a tendency toward column arrangement of the grouped acini was frequent, especially in the more peripheral portions of the tumor where invasion of the capsule could be demonstrated. For the most part, the cells were flat to cuboidal; the intra-acinous spaces were small and not infrequently displayed small, irregular, deeply staining, eosinophilic, colloid collections. Mitotic figures were only occasionally seen.

A slow, degenerative, coagulation necrosis, presumably on the basis of impoverished blood supply, with marked hyaline formation, was widespread throughout the entire tumor. Peripherally, broad columns of the eosinophilic-staining material separated the described columns of tumor acini. Imbedded in the hyaline appeared relatively frequent, thin-walled, flattened, longitudinally placed blood vessels filled only partially with blood elements. The occasional areas of densely packed spindle cells were arranged longitudinally or in whorls. They presented occasional mitotic figures. A single small area displayed collections of relatively widely separated, irregularly shaped and sized cells suggestive in general appearance of a rather malignant mixed-cell sarcoma. (Fig. 6.) However, these collections gave evidence of their carcinomatous nature by the presence of scattered, irregularly formed acini with eosinophilic colloid content.

The immediate postoperative course of the patient was good. Most of his complaints were referable to the bladder condition. An indwelling catheter had been installed postoperatively. Within the first twenty-four hours it was noted that there was an almost complete disappearance of the prominence of the chest vessels. The patient stated that his head felt clearer. He ate without difficulty on the second postoperative day. At no time was there any difficulty in breathing. In fact, breathing appeared to be improved almost immediately postoperatively. The patient was up in a wheel chair on the fifth day and was walking on the seventh. He left the hospital on the eleventh postoperative day, at which time the apical pulse was 84 and the radial pulse was 80.

Despite repeated attempts to get the patient to return for planned postoperative irradiation, he persistently refused to return to the hospital.

Fig. 7. The patient two and one-half months after operation. The fullness on the right at the level of the scar was suggestive of a recurrence.

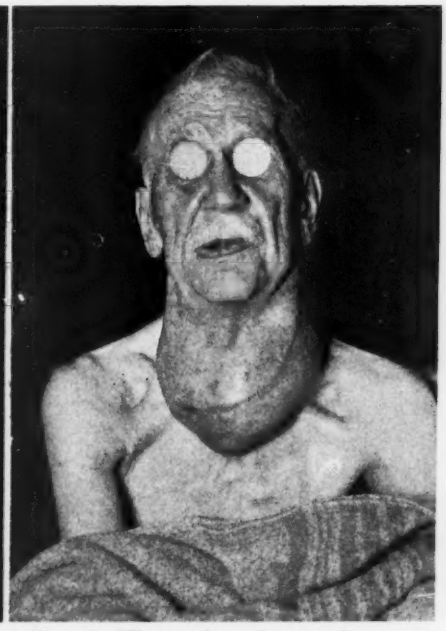

Fig. 8. The patient four and one-half months after operation. The mass attained this size over a period of two months. In size and general appearance it resembles first tumor. In texture, however, it was more elastic and softer.

Follow-ups were maintained by personal visits to his home. Over the next two and one-half months his general condition was good. He stated that he felt well; there was a definite gain in weight. The pulse was mildly irregular; the pulse rate averaged 85. There was no evidence of decompensation. The structures of the neck were in the midline. Locally, beneath the lower flap anteriorly, at the end of two and one-half months, a small, moderately firm mass could be felt. (Fig. 7.) It was suggestive of a local recurrence.

Following this, over the next two months, the small mass continued to enlarge with alarming rapidity so that four and one-half months after the first operation, it had attained a size almost as large as it was preoperatively. (Fig. 8.) At this time, after much persuasion, the patient returned to the hospital. The symptoms were essentially the same as before the first operation. Breathing difficulty with mild cyanosis were present; *x*-rays of the neck again displayed a marked tracheal compression.

A second operative procedure, similar to the first, with intratracheal anesthesia and supportive operative fluids and blood was carried out on February 15, 1940. The operative procedure *per se* was handled only fairly well. The operative findings were similar to those of the first procedure.

On this occasion, a grossly lobulated 20 by 15 by 8 cm. tumor was removed. In contrast to the first operative specimen, the second specimen was softer, friable and extremely cellular. Further, histological study showed that the tumor, almost in its entirety, was composed of actively growing spindle cells, the glandular elements being in the minority and found only in occasional small areas. Mitotic figures were not infrequent.

About four hours postoperatively, the patient died, persumably from cardiovascular collapse and delayed shock. Necropsy performed a few hours later, disclosed metastatic involvement of the peribranchial and peritracheal lymph-nodes. In addition, there were several small metastatic nodules just beneath the pleura of both lungs. As in both operative specimens the metastases displayed glandular

elements with formed acini in addition to areas showing spindle-shaped cells.

SUMMARY AND COMMENT

A case has been described of a diffuse adenocarcinoma of the thyroid gland in an old man, age eighty-one.

Clinically, the case illustrates the operative possibility for the relief of tracheal compression in the seemingly hopeless, inoperable type of case in which primary irradiation of a tumor, composed for the greater part of hyaline material, would not be effective.

Pathologically, it reconstructs the course and growth, presumably from a gland with adenomatous changes, of a primarily mildly malignant adenocarcinoma, with late invasion of the capsule by the glandular elements, and final rather marked increase in malignancy and the cellular assumption of a more embryonal state in localized, smaller areas. Later still, following the radical removal of the tumor, an astonishingly rapid growth of the remaining malignant elements took place. The recurrent tumor, in the greater part, was composed of rapidly growing spindle cells. The outstanding feature of the original tumor was the enormous production of hyaline material. Further, the tumor illustrated its fundamentally carcinomatous nature in the metastases in which were found both formed acini, with eosinophilic colloid content, and areas of spindle-shaped cells.

Finally, it appears reasonable to assume, on the basis of the cellular character of the recurrence, that its growth could have been inhibited by irradiation following the first operative procedure.

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LARGE TUMOR OF VAGINA

T. H. SHANAHAN, M.D.
On Surgical Staff, Jamestown General Hospital
JAMESTOWN, NEW YORK

LEIOMYOMA of the vagina is a comparatively rare tumor. Up to 1930 there were 270 reported cases in the literature. In almost all of the reported cases the tumors were small, many not larger than a walnut. Eighty per cent are located on the anterior vaginal wall. They occur mostly between the third and fourth decades of life and are usually single and benign.

This case is of unusual interest because of the large size of the tumor:

CASE REPORT

A white female, age fifty-five years, complained of inability to urinate at times which progressively became worse for the past three months. Physical examination revealed a middle aged, obese female. Her eyes reacted to light and accommodation; her teeth were in poor condition with many cavities. Tonsils were small and atrophic and her neck was obese and no tumor masses were found. The heart was normal in size and position, no murmurs, and good tone. The lungs were normal with no audible râles. The abdomen was prominent but no tumor masses were palpable. The labia were normal. The perineum was relaxed; there was a protrusion at the vagina which resembled a rectocele, but on palpation it felt like a large tumor deep in the pelvis behind the mucous membrane of the vaginal wall. On rectal examination a large tumor mass could be felt deep in the pelvis. The extremities and reflexes were normal.

The urine showed a small amount of albumin. The hemoglobin was 60 per cent. The leukocytes were 7,000; red cells 3,600,000. A transfusion of 600 cc. of citrated blood was given the day before the operation.

The preoperative diagnosis was fibroid tumor deep in the pelvis originating from the uterus. (Fig. 1.)

Operation. A low midline incision was made. The uterus and cervix were small; tubes and ovaries were normal. Then with one hand in the pelvis and the other hand in the vagina I was able to outline the vaginal mass which

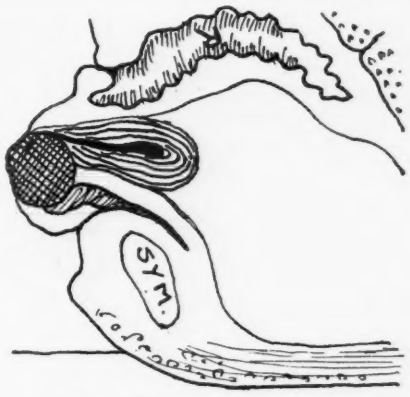

FIG. 1. Illustration of tumor.

was as large as an ordinary grapefruit which completely filled the vagina. The mass was attached to the anterior vaginal wall, just anterior to the cervix and extended to the urethra. A sterile towel was placed over the abdominal incision and the patient placed in the lithotomy position. By placing retractors in the vagina a line of cleavage was found and the tumor mass separated from the anterior vaginal wall. Because of the large size of the tumor, it had to be split in the midline and the two pieces removed separately. All bleeding points were clamped and a pack placed in the vagina. After inspecting the pelvis from above for injury the abdominal incision was closed in layers.

The pack was removed in twenty-four hours. On the fourth day the patient began to urinate and made an uneventful recovery. When last seen, one month later, she seemed perfectly normal. Pathological report: leiomyoma.

SUMMARY

Leiomyoma of the vagina are comparatively rare tumors. They are usually small and are located principally on the anterior vaginal wall. This case is of special interest because of the large size of the tumor.

New Instruments

BEDSIDE HEAD REST FOR EMERGENCY HEAD INJURIES*

ABRAHAM KAPLAN, M.D.
Associate Neurosurgeon, Mt. Sinai and Bellevue Hospitals
NEW YORK, NEW YORK

IN our "all-out" attack upon the problem of head injuries which we are bound to encounter during this war and possibly during air raids, it will be necessary to modify some of our tactics in the treatment of such patients.

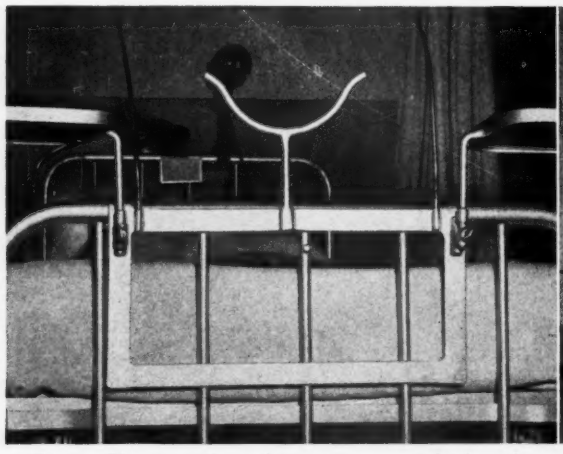

FIG. 1. Close-up view of apparatus attached to the foot of usual hospital bed.

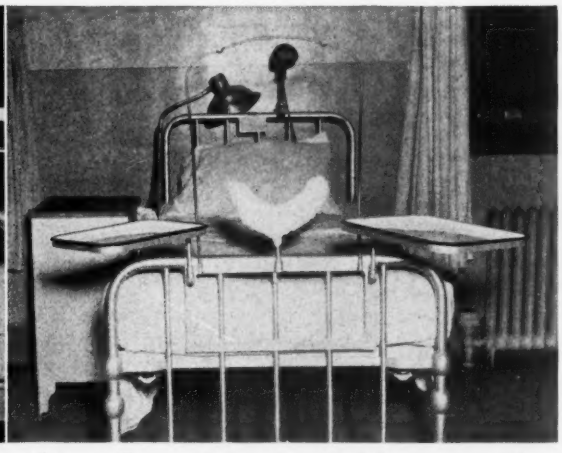

FIG. 2. Front view of padded head rest with trays and head screen.

Reliable statistical data as to the incidence of head injuries on the present various battle fronts or during air raids are as yet unobtainable. Exact numbers or percentages of casualties are apparently withheld for military reasons. However, from recent British reports head injuries are admittedly high. Olivocrona[1] in referring to the injuries during the war from 1914 to 1918 states that about 50 per cent of those who died on the battlefield had been shot in the head or neck, and that of the casualties passing through first aid stations 15 per cent were head injuries. In Cloward's[2] recent report of head injuries during the unexpected attack upon Hawaii he frankly states that the number of such injuries to be treated was so large, that it was necessary in many instances to delay operation twenty-four to thirty-six hours after the injury.

Since many patients with head injuries may have in addition wounds to other parts of the body, shock treatment will have to be started almost immediately. Indeed one must learn, re-learn, and keep on reminding oneself that "shock" treatment comes first. Well organized "shock" teams will save many lives.

We are all aware of the many factors which aggravate surgical "shock." Rough handling and unnecessary transportation are two of the most serious offenders. To eliminate their harmful effects we must organize our various surgical units, so that in so far as it is possible, the benefits of the

* From the Neurosurgical Service, Mt. Sinai Hospital, New York City.

operating room will be brought to the patient, rather than have the patient brought to the operating room.

Fig. 3. Side view of apparatus showing shape and slope of screen.

ing out of serious casualties. As an aid to the practical sorting out of head injuries, to the elimination of unnecessary trans-

Fig. 4. Patient in proper position with head fully exposed.

portation of patients, and to the facilitation of the treatment of many minor and some serious head injuries, the following bedside head rest is described and recommended.

Fig. 5. Side view with patient in position.

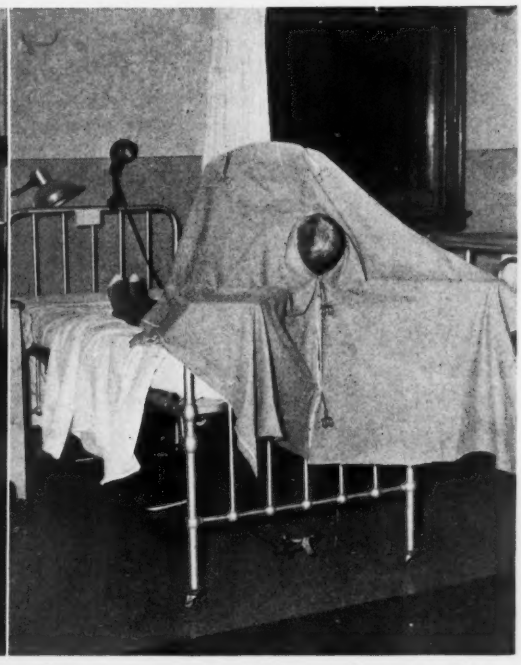

Fig. 6. Drapes applied exposing operative side. Note covering of trays.

Even during a minor catastrophe the operating rooms of most of our large hospitals will be taxed to capacity, and much will depend upon a rapid and realistic sort-

The apparatus consists of a curved head piece which is padded, with two adjacent trays of unequal size which can readily be rotated to the desired position, and a screen

for sterile drapes. (Fig. 1.) The apparatus is attached to the foot of the usual hospital bed with a minimum of effort (Figs. 2 and 3) and is so constructed that it will not tilt or slide.

FIG. 7. Full view of patient's face. This position is also convenient for additional treatments.

FIG. 8. Note how easily apparatus can be transferred from the foot of one bed to another.

The entire apparatus weighs about 12 pounds, 8 pounds without the trays, and the frame alone weighs 5 pounds. The parts are detachable and they can be shifted separately from the foot of one bed to another.

As the patient's head is placed toward the lower end of the bed he can easily be lifted so that this neck rests in the hollow of the padded head piece. (Figs. 4 and 5.) In this position the entire head can be gently rotated and inspected, the hair clipped and the scalp shaved.

With this exposure any scalp injury or hematoma can hardly escape detection. The scalp can then easily be prepared. A sterile drape (Fig. 6) is applied to encircle the site of injury, which at the same time covers the adjacent trays. The arrangement of the drape permits the nurse, who is in a good position to assist in manipulating and steadying the head, to have a full view of the patient's face. (Fig. 7.)

The sterile field now allows for simple wound cleansing or débridement. This setup may also prove satisfactory for more elaborate procedures by those specially trained.

After the wound is dressed, the patient is lifted back gently upon the pillows which are at the foot of the bed. The apparatus can now be detached and transferred with ease to the next bed. (Fig. 8.)

It is advisable to have several sets of these bedside head rests* which can be used in rotation with the assistance of a surgical nurse in sterile uniform. This nurse remains surgically clean and is in charge of a cart supplied with sufficient equipment for a number of cases. With such organization many head injuries of considerable severity can be efficiently treated with speed, simplicity and a minimal of shock.

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* The apparatus with minor modifications is also suitable for treatment of injuries about the face, and can even be used for foot or leg injuries with the patient in proper position.

A SIMPLE APPARATUS FOR THE ADMINISTRATION OF PENTOTHAL SODIUM OXYGEN ANESTHESIA BY ONE ANESTHETIST

PAUL MECRAY, JR., M.D.
Associate Surgeon, Cooper Hospital
CAMDEN, NEW JERSEY

INTRAVENOUS anesthesia frequently requires the services of two anesthetists. This has retarded the use of pentothal sodium oxygen anesthesia even though it is recognized as an aid in both major and minor surgery. I have been using for over a year a simplified apparatus which permits one anesthetist comfortably to inject 2.5 per cent pentothal sodium intravenously and at the same time administer oxygen. The apparatus has the added advantage that the patient's arm may be abducted on an arm board or kept at the side. It is composed of a No. 20 gauge 1½ inch intravenous needle, a glass observation tube, 30 inches of small gauge special rubber tubing such as is used in a fractional spinal anesthesia apparatus, a stopcock, and a 50 cc. Luer-Lok syringe which will fit the stopcock. A stand which will fasten onto any operating table is used, and attached to it is a swivel jointed burette holder which permits the syringe to be clamped at a convenient height or angle.* When the apparatus is used with the patient's arm held at the side we have found that there is less chance of dislodging the needle if it is inserted proximally and the tubing then curved back on itself by means of a piece of metal suitably fashioned.

FIG. 1. Apparatus for the administration of intravenous anesthesia.

The induction of anesthesia is rapid and rarely have we seen a needle become dislodged. Back flow of blood into the observation tube does not occur. This fact combined with our technic of giving minute injections at frequent intervals results in even anesthesia and only rarely in an occluded needle.

* This apparatus is supplied by the George P. Pilling Company, Philadelphia.

Selected Book Reviews

DURING the past few months many excellent books on various medical topics have been published. This month, instead of a long review of only one book, we are offering short, thumbnail reviews of what we believe are recent outstanding publications.

In gynecology we have Novak's "Gynecology and Female Endocrinology."* In about 600 pages the author has given us one of the best and most satisfying works on these subjects to date. Although the student may refer to several excellent books on gynecology, we place Novak's work at the head of the list. It has been cut to the bone and has not a single page of padding; nevertheless, it is complete and is very well written. The profuse illustrations truly illustrate the text and the colored pictures are splendid. Purposely, the author has omitted the details of operative technic. Worth-while and recent references are at the end of each chapter and the index is adequate. Both author and publishers are to be congratulated in offering at this time, when the world is topsy-turvy, an up-to-the-minute, readable, authoritative and scientific work on gynecology and female endocrinology.

Should one wish for a complete work on "Malignant Disease and Its Treatment by Radium" we refer him to a book of that title by Stanford Cade.† It is a large book (nearly 1,300 pages) and has 623 illustrations, many in color. The author writes: "Successful treatment (of cancer) depends upon three main factors: a sound knowledge of the disease; a wise selection of the method of treatment; and accurate and skillful technique." Covering a period of fifteen years the author saw about 4,000 cases of malignant disease; of these about 3,000 patients were treated by radiation either as the sole method of therapy or in combination with surgery. A record of each case was kept from the very beginning. The material

* Gynecology and Female Endocrinology. By Emil Novak, A.B., M.D., D.SC. (Hon. Dublin), F.A.C.S. Boston, 1941. Little, Brown and Company.

† Malignant Disease and Its Treatment by Radium. By Stanford Cade, F.R.C.S. Baltimore, 1940. The Williams and Wilkins Company. Price $18.00.

thus gathered laid the foundation for this volume. If one can afford the price, this volume is worth owning. A careful study of its pages will bring one up-to-date on the diagnosis and treatment of malignant disease.

"Preeclamptic and Eclamptic Toxemia of Pregnancy"* is a book for the man who does obstetrics. It is a short, concise work (398 pages) by Lewis Dexter and Soma Weiss. Dr. Dexter is Research Fellow in Medicine at the Harvard Medical School. Soma Weiss, also of Harvard, died recently. He was one of the "great" physicians and he died a very young man. The book was written in collaboration with Florence W. Haynes, Herbert S. Sise and James V. Warren.

This monograph is based on an investigation of preeclamptic and eclamptic toxemia of pregnancy conducted over a period of three years. The investigation was stimulated by many confusing problems confronting one of the authors during the fourteen years he acted as the medical consultant of the Obstetrical Service of the Boston City Hospital.

The student will find a full bibliography at the end of each chapter and obstetricians would do well to read this text carefully.

The lay press gave Gregory Zilboorg's "A History of Medical Psychology"† high praise. No author could wish for more laudatory reviews, and from a professional viewpoint we can echo these praises. The title tells us what the book is about, and a perusal of its contents will convince the reader that he is deep in the pages of a rare and delightful work. One need not be a physician to enjoy this history of man's long struggle with mental illness, but physicians are sure to get the "something more" from its pages than any layman. We recommend this work for reading during that half hour before bedtime.

If we had our way we would have every surgical intern, resident and young physician in practice own a copy of Ferguson's "Surgery of the Ambulatory Patient."‡ When one considers the thousands

* Preeclamptic and Eclamptic Toxemia of Pregnancy. By Lewis Dexter, A.B., M.D. and Soma Weiss, A.B., M.D. Boston, 1941. Little Brown and Company. Price $5.00.

† A History of Medical Psychology. By Gregory Zilboorg, M.D. In Collaboration with George W. Henry, M.D. New York, 1941. W. W. Norton Co., Inc. Price $5.00.

‡ Surgery of the Ambulatory Patient. By L. Kraeer Ferguson, M.D., F.A.C.S. Philadelphia, 1942. J. B. Lippincott Co. Price $10.00.

of physicians, general practitioners and budding specialists, who see the great majority of the surgical ills of mankind that are labelled minor or ambulatory, it would be well for all of these to become expert and know the "right answers" which are to be found in this work.

This is a complete book (over 900 pages) and covers every conceivable injury and anomoly. It is profusely illustrated. In section one we are told how a room should be equipped to handle the surgery of the ambulatory patient, what anesthesia to employ, how to prepare for and conduct an operation on such patients, pre- and postoperative care, dressings and bandages, burns, foreign bodies, open wounds, superficial cysts and tumors. Section two deals with regional surgery and the third part of the book considers the musculoskeletal system. We suggest that those who are engaged in this type of work own a copy of Ferguson's work. They will refer to it often and many will read it from cover to cover.

"A Textbook of Surgery by American Authors," edited by Frederick Christopher is offered in a third edition, which has been completely revised and reset. This outstanding work,* first published in 1936, is the result of the contributions of almost two hundred American surgeons. Their names make a long Who's Who of the cream of our profession.

Suffice it to say that this is a textbook in every sense of the term and covers the surgical field from "abdominal distention" to "zygomatic bone fractures." It has 1,718 text pages and a long index. The illustrations are not too many and are of a high order. It is just the book to have on a library shelf for handy reference or to read on subjects that particularly interest one.

In the Foreword of his book the author, Dr. Goodrich C. Schauffler, writes: "In 1925 I saw a little girl of three with gonorrheal vaginitis. Until that time I had not examined prepubertal female genitalia. I had been taught nothing concerning them in medical school, during my internship or even during a specialized residency in obstetrics and gynecology. So I went to the texts and found only fragmentary and uncoordinated information. . . . The obvious need for more adequate information suggested study."

* A Textbook of Surgery by American Authors. Edited by Frederick Christopher, B.S., M.D., F.A.C.S. Third Edition. Philadelphia, 1942. W. B. Saunders Company.

As a result of this study we have a much needed work,* "Pediatric Gynecology." The author covers psychological factors in the management of a child, gives a detailed description of the external genitalia and vagina, and goes thoroughly into their defects, discussing disorders during adolescence and the onset of menstruation, preoperative, operative and postoperative management, special urologic and proctologic considerations, and at the end of the book the author devotes a chapter to social service (written in collaboration with Mary L. Eggleston—most physicians will learn a lot from reading this chapter) and medicolegal aspects. The author closes with a consideration of basic standards of hormone units and state agencies administering child welfare services.

This pioneer book, full of practical facts, contains sixty-six illustrations and is instructive and interesting. The gynecologist will be rewarded in studying its pages, and to general practitioners of medicine, who see pediatric gynecologic conditions so often, the ownership of this work comes under the heading of a "must."

Every gynecologist is familiar, or should be familiar, with the history and work of the late Joseph Price. His pupil and successor, James William Kennedy, has carried on certain underlying principles as laid down by Price. Not the least of these has been the technic for vaginal hysterectomy. For many years the great majority of those engaged in gynecological practice listened to the plea for removal of the uterus via the vaginal route but continued to follow the abdominal technic. Within recent years, however, more and more operators have resorted to the vaginal route, and today, vaginal hysterectomy in many clinics is routine and not the exception to the rule. For this we can thank Dr. Kennedy. And so we welcome his thorough work† on this subject.

Suffice it to say that the authors (James William Kennedy and Archibald Donald Campbell) have considered every phase and aspect of the subject. They discuss vaginal hysterectomy versus abdominal hysterectomy, use of the cautery, and many other topics, such as cystocele and rectocele in procidentia, cervical polyp, the infected puerperal uterus, malignancy, vaginal removal

* Pediatric Gynecology. By Goodrich C. Schauffler, M.D. Chicago, 1942. The Year Book Publishers, Inc. Price $5.00.

† Vaginal Hysterectomy. By James William Kennedy, M.D., F.A.C.S. and Archibald Donald Campbell, F.R.C.S., F.A.C.S. Philadelphia, 1942. F. A. Davis Company. Price $10.00.

of the cervic, pre- and postoperative care, and also go into detail regarding the technic of their operation. Louis E. Phaneuf wrote the Foreword and the work is rich in illustrations.

"The History and Evolution of Surgical Instruments,"* is a collector's item. In addition, it should appeal to the historian, to those who love and cherish nice things, the unusual and the rare, and who want these rarities in their libraries.

Many know of the remarkable collection of surgical instruments that were kept at the Royal College of Surgeons of London. But not many know that during the Nazi bombings the Royal College of Surgeons' building facing the beautifully parked Lincoln's Inn Fields was hit and this priceless collection of surgical instruments and also whatever records there were available to describe them were destroyed. Fortunately, Dr. Thompson, who needs no introduction to American readers, had thoroughly studied this material and had prepared this comprehensive survey. Parts of this book have appeared in the British Journal of Surgery. Chauncey D. Leake, who wrote the Introduction, concludes; "While this historical survey can never supplant the instruments themselves, it will serve to perpetuate the purpose of the collection, and to carry forward the humanitarian function of the Royal College of Surgeons in preserving the record of the developing technique of surgical art, so that all who appreciate it may profit from it. Dr. Thompson's book thus becomes another thrilling justification of the faith that no matter how powerful or insane the instruments of destruction may become, there is certain to remain an effective knowledge of the instruments of mercy and peace."

Henry Schuman has prepared a beautiful book that is a delight to hold and look at. Only 1,000 copies of this edition have been printed. Needless to say the author has written an absorbing and true history of the scalpel, amputation knife, saw, trepan, vaginal dilator and speculum, head-saws, artery and dressing forceps, bullet forceps and extractors, instruments for phlebotomy and venesection, tourniquets, trocars and operating tables. The book is well illustrated and there is an ample index.

* The History and Evolution of Surgical Instruments. By Dr. C. J. S. Thompson. New York, 1942. Schuman's. Price $8.50.

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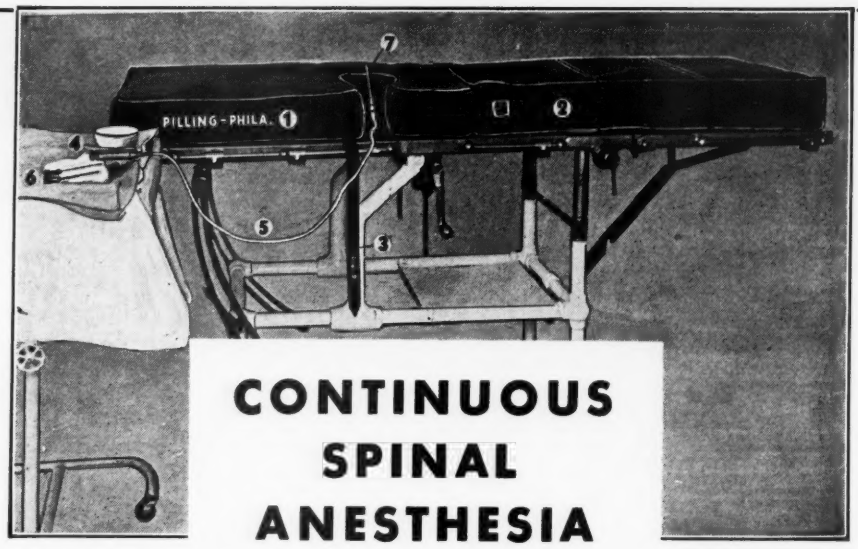

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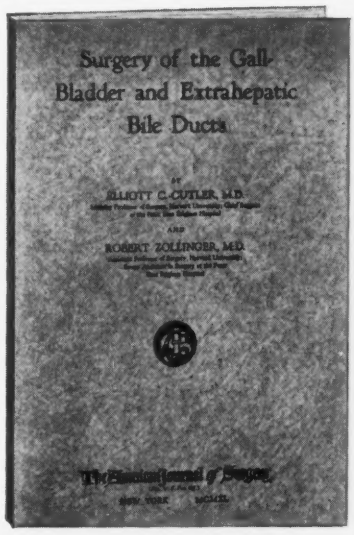

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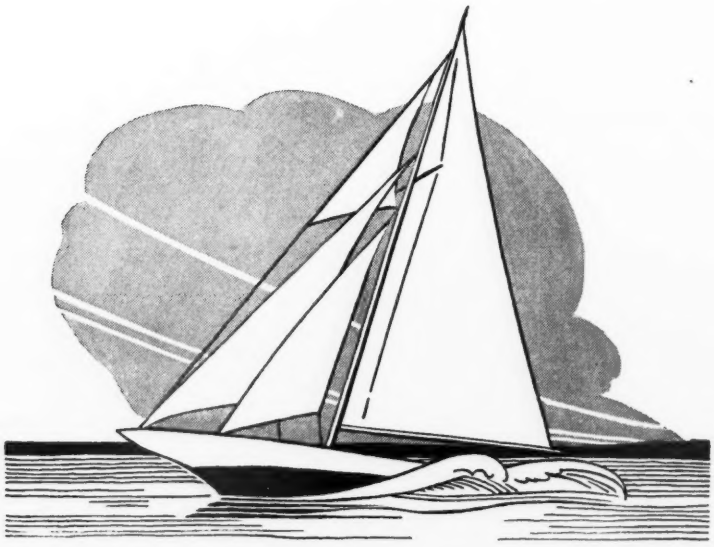

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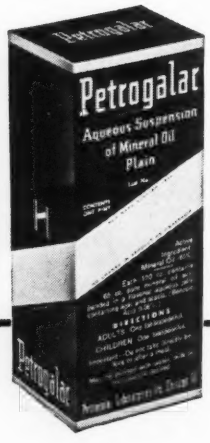

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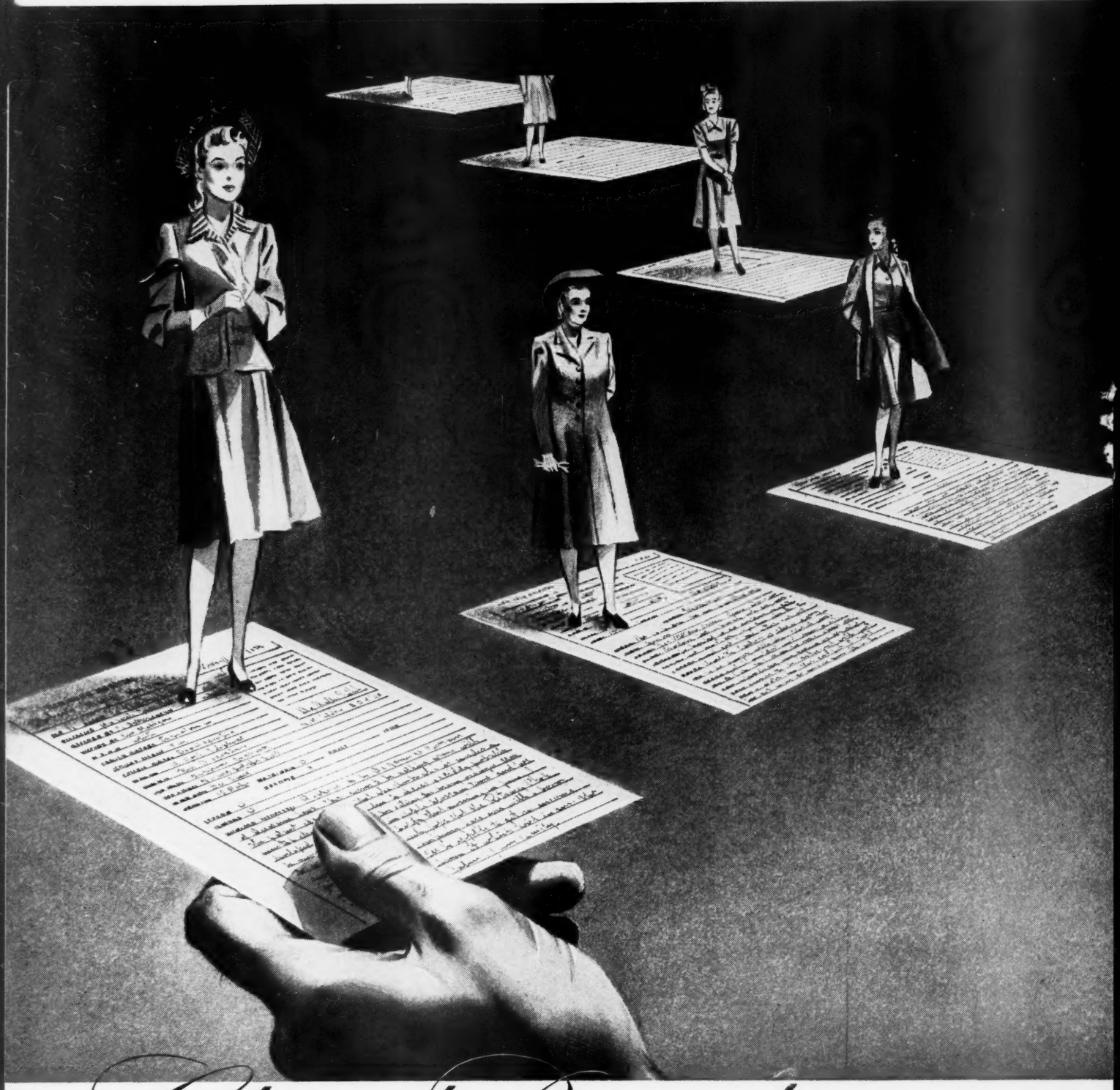

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The American Journal of Surgery

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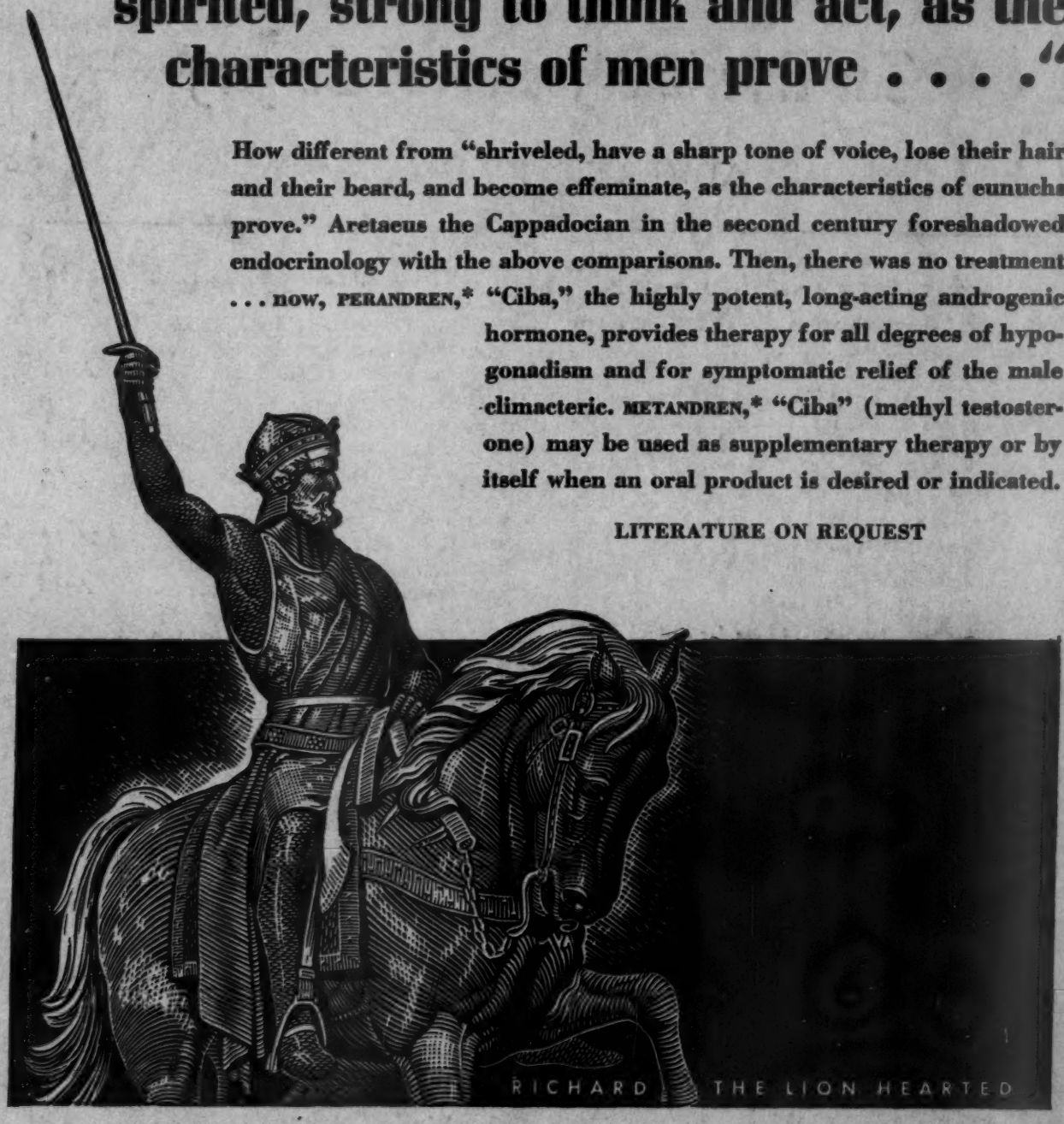
"Well braced in limbs, hairy, well voiced, spirited, strong to think and act, as the characteristics of men prove . . . ."

How different from "shriveled, have a sharp tone of voice, lose their hair and their beard, and become effeminate, as the characteristics of eunuchs prove." Aretaeus the Cappadocian in the second century foreshadowed endocrinology with the above comparisons. Then, there was no treatment . . . NOW, PERANDREN,* "Ciba," the highly potent, long-acting androgenic hormone, provides therapy for all degrees of hypogonadism and for symptomatic relief of the male climacteric. METANDREN,* "Ciba" (methyl testosterone) may be used as supplementary therapy or by itself when an oral product is desired or indicated.

LITERATURE ON REQUEST



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*Trade Mark Reg. U. S. Pat. Off. Words "Perandren" and "Metandren" identify the products as testosterone propionate and 17-methyl-testosterone respectively of Ciba's manufacture.

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